THE ILLUMINATING ENGINEER

THE JOURNAL OF

GOOD LIGHTING

LIGHT LAMPS FITTINGS AND ILLUMINATION

OIL GAS ELECTRICITY ACETYLENE PETROL-AIR GAS ETC.

OFFICIAL ORGAN of
The Illuminating Engineering Society
(Founded in London, 1909; Incorporated 1930)
and of
THE ASSOCIATION OF PUBLIC LIGHTING ENGINEERS
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International Illumination Congress.

In this issue we conclude the account of the International Illumination Congress held in this country during September 1st—19th, 1931. A summary of the papers read at Buxton and Birmingham is given and there is a specially contributed account of the proceedings at the meeting of the International Commission on Illumination at Cambridge. Some further floodlighting installations, both gas and electric, are described and illustrated.

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The British Standard Specification for Street Lighting

THE revised version of the British Standard Specification for Street Lighting* has now made its appearance and we may recall that an analysis of the chief departures from the original clauses was presented by Mr. C. C. Paterson at the International Illumination Congress.

We think it will be generally conceded that the Specification has been improved by the changes. Some of the difficulties involved could, indeed, hardly be avoided, for they really arise from the effort to frame the Specification in such a way as to fulfil two or more distinct functions. The Specification is regarded primarily as a statement of the conditions that one would wish to see fulfilled in various classes of streets. It is not a legal standard but yet it has sufficient significance to induce caution in framing demands. There is a natural disposition to ask for what may fairly be expected rather than what one would consider ideal.

But the Specification is something more than a mere statement of desirable conditions. It is also intended to serve as a basis for tenders. This, too, renders some degree of compromise not only judicious but inevitable.

The two dual functions of the Specification doubtless help to explain one inclination remarked upon by Mr. Paterson—the tendency to use minimum illumination as a criterion of excellence instead of, as intended, a method of grouping. It has always seemed to us that human nature could hardly do otherwise. Specification of minimum illumination *only* obviously encourages an attempt to accentuate the candle-power at angles slightly below the horizontal and thus achieve a relatively high mid-span illumination with an apparently low consumption of energy—a method which inevitably occasions glare. It is also apt to be interpreted as giving equal ranking to two systems of lighting which furnish equal mid-span illumination, though the total volume of light provided in the street in one case may be vastly greater than in the other. One recalls that the desirability of paying some attention to average illumination has been emphasized again and again whenever the Specification has been discussed; we think, therefore, the committee has acted wisely in making provision for a statement of average illumination in tenders, even bearing in mind the difficulty in ascertaining this item. (The isocandle diagrams will, we fear, appear formidable to many prospective users of the Specification.)

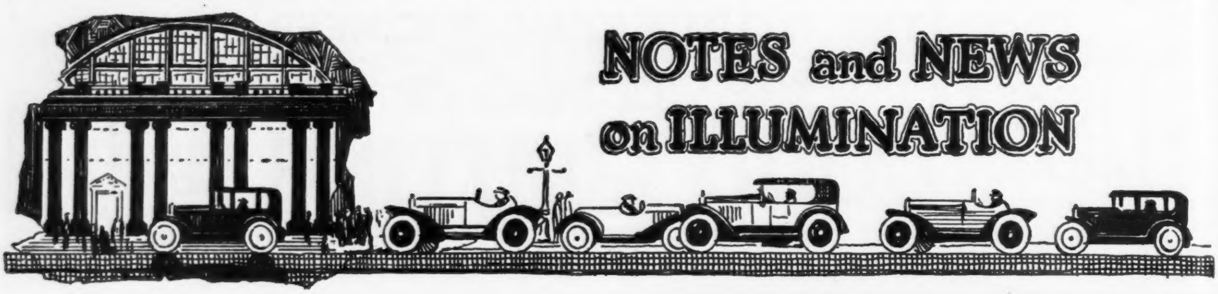
The above considerations are also in part responsible for the introduction of maxima for spacing ratios, a desirable addition but one which may prove difficult to apply. In this, as in the table of mounting heights, the committee has taken a new step in specifying "recommended" values as well as maxima and minima respectively. This method of specifying values was definitely rejected by those responsible for the reports on School and Library Lighting issued recently by the Illuminating Engineering Society. We confess that we feel doubtful about the wisdom of giving two sets of values. The step may, however, derive some justification from the dual functions of the Specification alluded to above.

Other useful additions to the Specification include definitions covering highway, carriageway, footway, kerb and margin and values of footway-illumination. There is also a proviso that in the case of streets lighted on one side only the height of the posts must not be less than two-thirds of the width of the roadway.

We note with satisfaction the disappearance of the appendix containing the method of evaluating glare. It is hardly surprising to learn that even the simplified method, given in the 1927 edition of the Specification, was judged to be too involved for practical use. Experience during the demonstrations at Sheffield, in 1928, indicated that the "glare factor" thus calculated was apt to prove misleading; it was always evident that the method of calculation, besides being open to possible criticism in principle, was too intricate to be widely used.

Admittedly it is by no means easy to frame clauses such as can usefully be applied to limit glare in streets. Yet we consider this to be one of the most important of all aspects of street lighting. There is no other field of lighting where glare is tolerated in anything like the same degree. We are loathe to pin our faith to mathematical formulæ in this connection but the somewhat meagre guidance given in Clause 22 might surely be amplified with advantage, for example, by introducing some comments on the utility of diffusing glassware. In practically all other fields of lighting the value of diffusing media in diminishing glare and improving the appearance of lighting equipment is recognized. It is surely an anomaly that the use of unscreened filaments and mantles in the streets should still be regarded with complacency.

* A British Standard Specification No. 307, 1931. Available from the British Engineering Standards Association, 28, Victoria Street, Westminster, S.W.1., post free 2s. 2d.



A Remarkable Floodlighting Installation

We are indebted to Mr. R. Beveridge, Inspector of Public Lighting in Edinburgh, for the accompanying pleasing illustration showing the floodlighting of the historic Castle in that city. By general consent this was quite one of the most effective bits of floodlighting carried out in connection with the Congress. The floodlighting expert, like an artist, is dependent in no small measure on his subject. The lofty isolation of the Castle at Edinburgh makes it an ideal subject for treatment. Its unique position, placed on dark crags, lifting it above its surroundings, was largely responsible for the romantic appearance of the illuminated building, which had something Wagnerian about it and was likened to the entrance to Valhalla. But apart from this the illumination was skillfully contrived. The positions of projectors were determined with judgment, and the inequalities in illumination (naturally not apparent in this distant view) proved to be a positive advantage.

A distant view of the floodlighted Castle, Edinburgh.

Illuminating Engineering Society (U.S.A.)

SILVER ANNIVERSARY CONVENTION.

The International Illumination Congress has run its course and our friends from the United States have returned to their country in time to participate in the Silver Anniversary of the Illuminating Engineering Society (U.S.A.), which was held in Pittsburgh during October 13th to 16th. The formation of the American Society ante-dated the foundation of the Illuminating Engineering Society in London by rather more than two years. It was on December 21st, 1905, that a small group of 25 enthusiasts met to discuss the formation of a society to deal with the science and art of illumination. The first regular meeting of the Society, the first of its kind in the world, was held in New York on February 13th, 1906, and the first Convention took place in Boston on July 30th and 31st, 1907. The present Twenty-fifth Annual Convention is thus an historic one in the history of the Society. As usual a highly attractive series of papers and reports, nearly 40 in number, was arranged. By the time these words appear this Congress, too, will have run its course. But we nevertheless take the opportunity of congratulating our friends in the States on the termination of 25 years of useful service, and on the prospect of a long series of equally successful conventions extending far into the future.

Domestic Lighting in South Africa

In a paper recently read before the South African Institute of Electrical Engineers Mr. F. H. Tyler made a strong plea for better lighting in the home. He presented an ingenious table showing how the 8,760 hours in the year are occupied by the normal householder, pointing out that one-quarter of our actual life (the hours of leisure and relaxation) is spent at home after dusk. He quoted from Mr. H. T. Young's recent paper on "Modern Domestic Lighting" to illustrate the trend of modern developments and urged that model house-wiring specifications should be prepared and sent out with every set of plans for new residences approved by the municipal authorities. Reference was made to the elimination of glare and the possibility of decorative effects. Excellent work has been done by the Lighting Service Bureau of the South African Electric Lamp Association, and interesting papers by Mr. Farthing and Mr. Evans have been read.

The Illuminating Engineering Society

(Founded in London, 1909; Incorporated, 1930)

PROVISIONAL PROGRAMME OF MEETINGS FOR SESSION 1931-32

In what follows we reproduce the list of Ordinary Monthly Meetings which has been recently circulated to members of the Illuminating Engineering Society. Until otherwise announced, meetings will be held at 7 p.m., and will be preceeded by light refreshments at 6-30 p.m.

1931

Oct. 20th. OPENING MEETING (devoted to reports of Progress, Exhibits, etc.). (*To be held at the E.L.M.A. Lighting Service Bureau,* 15, *Savoy Street, Strand, London, W.C.*)

Oct. 30th. A General Discussion entitled "SOME IMPRESSIONS OF THE I.I.C. FLOODLIGHTING" will be opened by MR. PERCY GOOD. (*To be held in the House of the Royal Society of Arts,* 18, *John Street, Adelphi, London, W.C.*)

Nov. 18th. Addresses will be delivered by MR. R. H. MONIER-WILLIAMS (Clerk to the Tallow Chandlers Company) and by MR. W. J. A. BUTTERFIELD ("The Historical Development of Gas Lighting") and by MR. J. SWINBURNE ("The Early Days of Electric Lighting"). (*To be held in the Hall of the Tallow Chandlers Company,* 4, *Dowgate Hill, London, E.C.*)

Dec. 11th. PRESIDENTIAL ADDRESS to be delivered by SIR FRANCIS GOODENOUGH, C.B.E. (*To be held in the House of the Royal Society of Arts,* 18, *John Street, Adelphi, London, W.C.*)

1932

Dates have been provisionally allocated for papers on the following subjects :—

January. MOTOR CAR HEADLIGHTS.

February. PRINCIPLES AND PROBLEMS IN CHURCH LIGHTING. (Various speakers.)

March. PROGRESS IN DECORATIVE LIGHTING.

For subsequent months papers are anticipated on Industrial Lighting, The Work of a Public Lighting Dept., and the Application of Light to Agriculture and Horticulture. It is also hoped to arrange some additional informal Meetings and Visits, and Special Meetings at several Provincial centres.

Impressions of Papers read before the International Illumination Congress

(*Continued from p.* 238, *October,* 1931.)

IN our last issue we dealt with the papers read at the meetings of the Congress held in Glasgow and Edinburgh. In what follows we give a summary of those presented at Buxton and Birmingham.

Architectural Lighting.

The section on Architectural Lighting, in which seven papers were presented, attracted special interest.

The first paper on the list by Dr. K. Norden, entitled "*Shadows and Half-Shadows*," involved an analysis of the shadow-conditions arising in various types of lighting installations. Formulæ relating to shadows produced respectively by point-sources and by light-sources of extensive area were derived and several examples of the predetermination of the density of shadows, e.g., at a work-place in a factory, were worked out. The value of such an analysis is specially evident in cases where the shadows are very soft (as occurs, for instance, when light is derived largely from an illuminated ceiling) so as to be undetected by the eye even though they may materially diminish the available illumination. The paper was also of interest in connection with architectural lighting, the success of which depends in no small degree on shadow-formation.

A comprehensive paper by Mr. R. W. Maitland and Mr. H. Robertson ("*Electric Light as Related to Architecture*") reviewed progress since the 1925 Exhibition in Paris, which is regarded as the final breakaway from converted gas candelabra and suspended fittings towards the distribution of light over large areas of low brightness. In discussing architectural lighting designs a distinction should be drawn between the use of light (1) as an illuminant and (2) as a combined illuminant and element in decoration. In the former case the utmost simplicity is desirable but the latter case offers infinite scope to the designer. The authors discussed in turn indirect lighting, semi-indirect lighting and combinations of direct and indirect lighting, illustrating typical methods of application, and giving useful hints in regard to method. Exterior lighting was considered under four headings (1) floodlighting, (2) illuminated windows (lighting from the inside), (3) applied lighting in the form of boxes or screens, and (4) lighting by continuous tubing of the neon type. There are really two distinct methods of floodlighting, one covering the entire façade, the other consisting of local or partial treatment. An English school of treatment with characteristic features is developing, and the authors mention some typical modern installations which show the trend of this movement. These and other installations are illustrated; the Cambridge, Savoy and New Victoria theatres are of special interest though the treatment of some of the hotels (Dorchester, Strand Palace, Savoy, and Berkeley) also shows novel features. The authors emphasize the importance of mobility and flexibility and psychological effect. Possible lines of development include the application of neon tubes to internal decoration.

MM. H. Maisonneuve and J. Wetzel, in their contribution surveying *Developments in Artistic Lighting in France during* 1928-31, likewise refer to the Exposition des Arts Decoratifs in Paris in 1925 as an important point of departure. The present tendency of lighting in France is discussed and the work of the committee set up by the Asociation des Ingenieurs de l'Eclairage is summarized. A feature is the progressive co-operation of lighting experts and artists, whose views have had a notable influence on recent designs. One striking feature revealed in recent architectural lighting schemes is the continually extending use of diffusing glass in many varied forms. Theatres and picture palaces continue to afford good openings for novel methods of lighting, but perhaps the best opportunities are to be found at exhibitions, such as the recently opened Colonial Exhibition in Paris, for which original fittings were designed.

In the afternoon, the opening item was a paper by Mr. L. Kalff (Holland) on "*Illumination and Architecture.*" The author started with the assumption that light and architecture are inseparably connected. He showed how from their earliest beginnings architectural shapes, profiles and ornaments have been influenced by the conditions of daylight in the country where the buildings were designed. Thus in the extremely dry climate and bright sunshine of Egypt large shapes and details and shallow reliefs of engravings developed. In northern countries, where sunlight is almost invariably diffused by mist, such low reliefs would be without effect. Hence in northern architecture, for instance, in the case of Gothic art, deep profiles and heavy ornaments are used; the general diffusion of light has also served to encourage plastic effects achieved by difference in colour. In the refined architecture of Greek temples the angle of incidence of sunlight is taken into account.

The adaptability of the electric light renders it possible to apply it to interior lighting in the same manner as was done for daylight in ancient interiors. Naturally perception how best to use such artificial light is only obtained gradually—just in the same way as the use of iron and concrete have had to pass through an experimental stage. The appearance of illumination ornaments and constructions both by natural and artificial light should be considered (instances of false impressions arising from errors in design were mentioned); the impression to be made by varying colour or distribution of light should be studied. The application of artificial light for the same purpose as that served by daylight, i.e., "in order to make visible to the beholder what we have endeavoured to express in our buildings," is a profound problem. Yet it creates an even greater wealth of possibilities than daylight has given us, because the light is under our complete control as regards its colour, intensity and direction.

In the future we may arrive at a new and combined form of architecture intended both for sunlight and for artificial light. The floodlighting of buildings from an entirely different angle to that at which the daylight falls, thus giving the building a deformed aspect by night, is but an initial and clumsy step. Already these consequences of modern lighting technique are being realized. One can even imagine a city illuminated at night in such a manner that the light radiates chiefly from the façades of the houses, which take the place of the bright sky that is seen by day.

This stimulating paper by Mr. Kalff was followed by a contribution entitled "*Engineering Aspects of Architectural Lighting*" by Mr. W. J. Jones. This dealt mainly with problems involved in designing "architectural lighting" systems. The conditions here are quite novel. Light is received mainly from extensive areas of low luminosity, horizontal, vertical or inclined. A marked feature is the

diminution in intrinsic brightness. Simple calculations based on the inverse square law may not apply, and the conventional "lumen method of design" is also difficult of application. Whilst "effect" is an important consideration architectural lighting must not be made an excuse for providing an inadequate supply of light for utility purposes. The illuminating engineer must still in these novel conditions be able to produce specified conditions of illumination.

Mr. Jones discussed various problems and precautions in the design of installations of this class. Tabular data illustrated the probable rise in temperature with both ventilated and unventilated recesses. It was shown that, provided there is adequate clearance of lamps and surroundings, the enclosure of lamps in unventilated wooden channels can be rendered quite safe. Other data illustrated the degree of brightness attained in various familiar "architectural" lighting devices and the desirable spacing of lamps with various forms of diffusing glass coverings. Tests of typical installations were summarized. Isolux curves and diagrams illustrated the height of the working plane on illumination. In the final section of the paper the importance of accessibility and easy maintenance was emphasized. It was suggested that the procedure in planning architectural lighting schemes should be as follows:—

(1) Decide upon the minimum illumination to be provided upon the plane of work or action, (2) determine the brightnesses necessary upon all lighted and luminous surfaces to give, in the aggregate, this desired illumination, and (3) deduce the total wattage and number of lamps necessary to give these predetermined values of brightness.

Other contributions of a mathematical character by MM. J. Dourgnon and P. Waguet discussed the determination of the brightness of reflecting surfaces under specified conditions and the dimensions of cornices and other equipment intended to screen sources of light from view.

The subsequent discussion turned chiefly on the methods of interesting architects in illumination and securing their co-operation in planning lighting schemes. Mr. Ward Harrison alluded to the courses of instruction in illumination arranged for architects in the United States, and to the reciprocal and equally important discourses on architecture designed for illuminating engineers. Some lantern slides showing striking and decorative lighting schemes installations similar to those periodically illustrated in the Transactions of the American I.E.S. were shown. Professor H. A. Barker mentioned that in addition to the famous "Paris prize" of 3,000 dollars awarded each year to architectural students a supplementary prize of 1,500 dollars for illumination design is now being awarded.

Some discussion ensued on the relation between the illuminating engineer and the architect, who, it was suggested, had already numerous other experts to deal with. It was pointed out, however, by Dr. Halbertsma that illumination is something quite distinct from such matters as heating, ventilation, etc., being an essential part of the architect's scheme on which the realization of his aims and aspirations depends.

A resolution suggested by Mr. W. J. Jones was framed to record the desirability of co-operation between the architect and the illuminating engineer, of courses of instruction on illumination in curricula for architectural students, and of consideration of light at an early stage in the construction of buildings. It was urged that these considerations should receive attention at the appropriate session of the International Commission on Illumination at Cambridge.

In the course of the discussion Professor J. T. Macgregor Morris took the opportunity of explaining the difference between the "inverse square" law for point-sources the "inverse" law for linear sources and the "no change" law which operates in cases where the distance at which the illumination is measured is small in comparison with the area of the luminous source from which this illumination is derived. Several speakers referred to the danger of deterioration in some forms of architectural lighting and Mr. Ward Harrison expressed an objection to the extensive use of built-in fittings, which had often the drawbacks of requiring special types of lamps and of being difficult of access.

Industrial Lighting.

The first contribution under this heading, by Dr. H. Lux, summarized the *Recommendations of the German Illuminating Engineering Society*. These are the result of 15 years of research. Conditions are now expressed in terms of brightness rather than foot-candles, hence the recommendation that working illumination should correspond to 50-200 "apostilb."* This relates to illumination in a horizontal plane, which is still considered the best value to specify. It is also recommended that surroundings should have a mean reflection factor of 0.4 to 0.6. Efforts have also been made to specify numerically the degree of shadow. The limitations of glare have been made more strict. The limiting value of brightness of lighting units under the conditions laid down in the original recommendations has been lowered from 0.75 to 0.2 stilb† for workshop lighting and from 0.5 to 0.3 stilb for general lighting conditions. Other points considered in general terms are degree of uniformity of illumination, steadiness of light, and colour of light.

A lengthy paper by N. Goldstern and F. Putnoky dealt with *lighting of textile factories*. Preliminary work had established a progressive increase in the perception of threads and the speed of recognition of defects as contrast and brightness were increased. These researches were supplemented by experiments conducted under working conditions in a woollen mill, obliquely placed mirror reflectors being used. This arrangement gave sharp shadows, especially on the warp-threads. The day's work done by four weavers under the original conditions and at three levels of illumination under the improved conditions was examined. Output and quality of work were both improved. An exact economic calculation suggested that the maximum profit accruing from the use of improved illumination (on the average about 5 pfg. per hour per loom) occurred at about 600 lux (corresponding to about 300 watt per loom).

A plea for "*humanitarian foot-candles*" (i.e., illumination beyond that actually necessary for productive work) was made by Dr. M. Luckiesh and Mr. Frank K. Moss. Artificial lighting was developed in an era when much less severe visual work was demanded and when there were great difficulties in obtaining adequate illumination. The relation between illumination and its effect is logarithmic—i.e., one foot-candle added to 2 or 3 foot-candles is far more effective than when added to 29 or 30 foot-candles. The difference in effect of 5 and 6 foot-candles or between 16 and 20 is difficult to appraise and there is no object in attempting to discriminate as closely as this between the requirements of different processes. Contrast also plays a most important part (e.g., if 10 foot-candles are needed for ordinary reading at least 100 may be

* One "apostilb" is equivalent to the brightness of a white (100 per cent. reflection factor) surface receiving an illumination of 1 lux (approximately 1-10th foot-candle).

† One "stilb" is a brightness of 1 candle (Hefner) per sq. cm.

wanted to attain the same speed, accuracy and ease in the case of type on a grey background, reflecting only one-tenth of as much light as white paper). In general, the maximum output of useful work is reached at a level less than 30 foot-candles. Nevertheless seeing may continue to become easier at very much higher levels (100, 300 or even 1,000 foot-candles). In the paper these conclusions were illustrated by many effective tables and diagrams. Data showing conditions of vision amongst school-children and workers are presented and the comparative benefit of higher illuminations to people with normal and subnormal vision is explored. Of special interest is the contention that an increase in the level of illumination may produce a permanent improvement in acuteness of vision.

A final paper in this section contained a very lengthy description of installations in which gas lighting is used. This was illustrated by numerous photographs. In an appendix a comparison of the spectra yielded by ordinary and "daylight" gas mantles was given.

The Lighting of Railways, Mines and Cinema Studios.

In this rather "miscellaneous" section the chief items were the contributions relating to railway lighting. A report presented by the *Comité de Directions des Grandes Réseaux de Chemins de Fer Francais* was noteworthy for the description of extensive floodlighting on railway systems whilst Mr. A. Cunnington's paper on "*Railway Lighting in Great Britain*" dealt to a large extent with the possibility of framing standards of illumination for platforms, goods sheds, goods yards, etc. After a brief historical introduction some special features of railway lighting, e.g., the similarity of platform-lighting to street lighting and the special importance of maintenance problems were pointed out. On platforms the importance of a low-spacing ratio was emphasized. A division into three classes (1) high roof, (2) low roof and (3) no roof was made, with corresponding minima of 1.0, 0.35 and 0.25 foot-candles. Experience of floodlighting in connection with shunting operations, etc., was given, the author expressing a preference for 500 or 1,000-watt projectors at heights of 30 to 45 feet in preference to more powerful units at greater heights. In conclusion some special applications of light on railways, such as the lighting of time tables, station clocks, station nameboards, etc., was discussed and useful hints on such problems were given.

This paper gave rise to an animated discussion in which the Chairman (Monseiur J. W. Partridge), Major Spittle, Mr. H. G. H. Wilson, Mr. G. H. Stickney and Mr. W. C. Goodchild took part. M. Partridge doubted the desirability of uniformity of illumination, and enquired whether hermetically sealed lighting fittings were usual on British railways. Major Spittle pointed out that the Ministry of Transport were the ultimate arbiters in such matters as standards of illumination. He also drew attention to the large number of stations where neither gas nor electric light is available and where vapourized oil and similar systems are used. He was disposed to prefer external lighting for clocks, time-tables and nameboards. Finally, he emphasized the very small cost of lighting in comparison with other expenses. Too much importance had been, in the past, devoted to saving and too little consideration to the losses arising from faulty operation of lighting systems. Mr. G. H. Wilson enquired whether the values of illumination were "recommended" figures or strictly minima, whilst Mr. Stickney believed that in the States the standards of illumination prevailing would be roughly three times those mentioned. Mr. Goodchild expressed doubt regarding the practice of switching off station platform lamps during slack periods chiefly owing to the risk of liability for accidents in unlighted places.

Mr. Cunnington, in reply, briefly indicated that the uniformity of illumination was intended to apply to actual "safety light"; anything over and above these values at special points would be advantageous. He strongly advocated internally illuminated nameboards and timetables, which were both effective and economical. He agreed that the standards of illumination could only be adopted with the approval of the Ministry of Transport but hoped that the backing of the Congress might be helpful in that direction and also in impressing the management of the railways with the importance and the practical value of good illumination as an economical proposition.

Mr. W. Maurice's paper entitled "*A Standard of Illumination for Mines*" consisted largely of a review of previous literature on this subject. Dr. T. Lister Llewellyn was probably one of the first to suggest a standard of illumination in mines, but the illumination then proposed, 0.1 foot-candles at the coal face, indicated what was possible at that time (11 years ago) rather than what is feasible to-day. Other experience by Dr. W. J. Roche and S. Adams is quoted. The latter considered that even rough work requires 3 foot-candles. To obtain such an illumination at the coal face with lamps at a distance of 3 ft. would require a beam candle-power of 27; but even this is not regarded as impracticable with modern types of lamps. In the course of the discussion Herr L. Schneider quoted some experience in mines in Silesia where opal bulb electric lamps yielding a general illumination of 2 foot-candles were installed. The improved lighting conditions resulted in an average increase in output of 25 per cent., accidents were reduced by 60 per cent., and the slate content of the coal was halved. The economic gain was considered to be twice the cost of the better lighting (5 to 10 pg. pf. per point).

Mr. W. A. Villiers in his contribution on "*Incandescent Lighting in Cinema Studios*" discussed in turn general lighting, spotlighting, close-up lighting, effect lights and sun lighting. The merits of incandescent lighting when a silent source is needed, as in making talking pictures, was well emphasized. In British studios about 70 per cent. of lighting is of this type. In general lighting 150-350 foot-candles is usual but in spotlighting much higher values may be requisite. The 3 kw. projector, operating with an 18-in. parabolic mirror, gives a maximun beam candle-power of 800,000. The 10 kw. lamp, used with a 30-in. mirror for sunlighting, produces a beam candle-power of about $5\frac{3}{4}$ million. Efforts to diminish the heat accompanying this intense illumination are described. For comfortable working the rise in local temperature experienced by the artist should not exceed 25°C. Tabular data showing the temperature rise at various distances and with projectors of capacity varying from 2 to 10 kw. are presented in the paper. A special form of glass screen, diminishing the heat by 50 per cent. and the light by 15 per cent. has been prepared. But the heat question is now less serious owing to improvements in efficiency of lamps, better lenses and faster film emulsions—which all tend to reduce the energy expended.

Miscellaneous Papers.

The remaining papers presented at Buxton can be only briefly summarized. Mr. Chelioti and Mr. B. P. Dudding were responsible for an instructive contribution on "*Precision in Incandescent Lamp Manufacture*" in which variations from the normal were closely studied. Dr. E. Lax and Dr. M. Pirani

contributed a comprehensive survey of *Artificial Daylight and Sunlight*, in the course of which the changes in pigments subjected to artificial light were studied and the resemblance to normal daylight of various forms of artificial daylight was discussed. The authors report favourable experience of gaseous tube illuminants (such as those using fluorescent carbon dioxide gas) in combination with incandescent lamps. Professor A. Blondel described *a binocular photometer* adapted for the study of searchlights, beacons, etc.

There remains for mention a group of three papers reviewing *applications of light in connection with agriculture and horticulture*. Mr. R. Borelase Matthews discussed the use of Electric Light on the Farm, firstly for the lighting of farm buildings, and secondly as a means of increasing production. Tabular data for the illumination of typical buildings were included and detailed information on the use of artificial light to increase the yield to the poultry farm was given. Various special problems, such as the irradiation of stock and foodstuffs with ultra-violet light, were also mentioned. The two other papers by K. Vogl (Germany) and S. Oden, G. Kohler and G. Nilson (Sweden) both dealt exclusively with the direct effect of light in horticulture. In the former the intensity of and period of artificial illumination to bring various plants into bloom were considered and in the latter detailed information on similar experiments at Upsala and elsewhere was given.

Motor-Car Headlights.

One of the chief subjects for discussion at Birmingham was "Motor-Car Headlights," on which five papers and reports were presented. The opening item was a brief report from the Japanese Committee summarising *experience with the R.A.C. disc.*

"*The Basis of International Agreement respecting the Lighting of Motor Vehicles*," by Dr. Born, pointed out that two kinds of light (main beam and anti-dazzle beam) combined formed the best system and dealt with the decisions arrived at in 1926 with suggested modifications for international approval and adoption. Mr. G. H. Stickney pointed out that there must be international agreement before decisions could be formulated but in the interval expressed his approval of the suggestions embodied in Dr. Born's communication pointing out that the terms adopted were complicated by the road surfaces that might exist and he therefore felt that the only practical specification should be the candle-power of the light-source. It was also necessary to ensure that the beam was extensive enough to deal with dipping contours while it should possess a smoothness of intensity, or absence of noticeable contrasts, between adjacent areas. He felt that results should be formulated and not the means by which they were to be obtained and that the physical dimensions of the beam ought to be decided and its sideways spread.

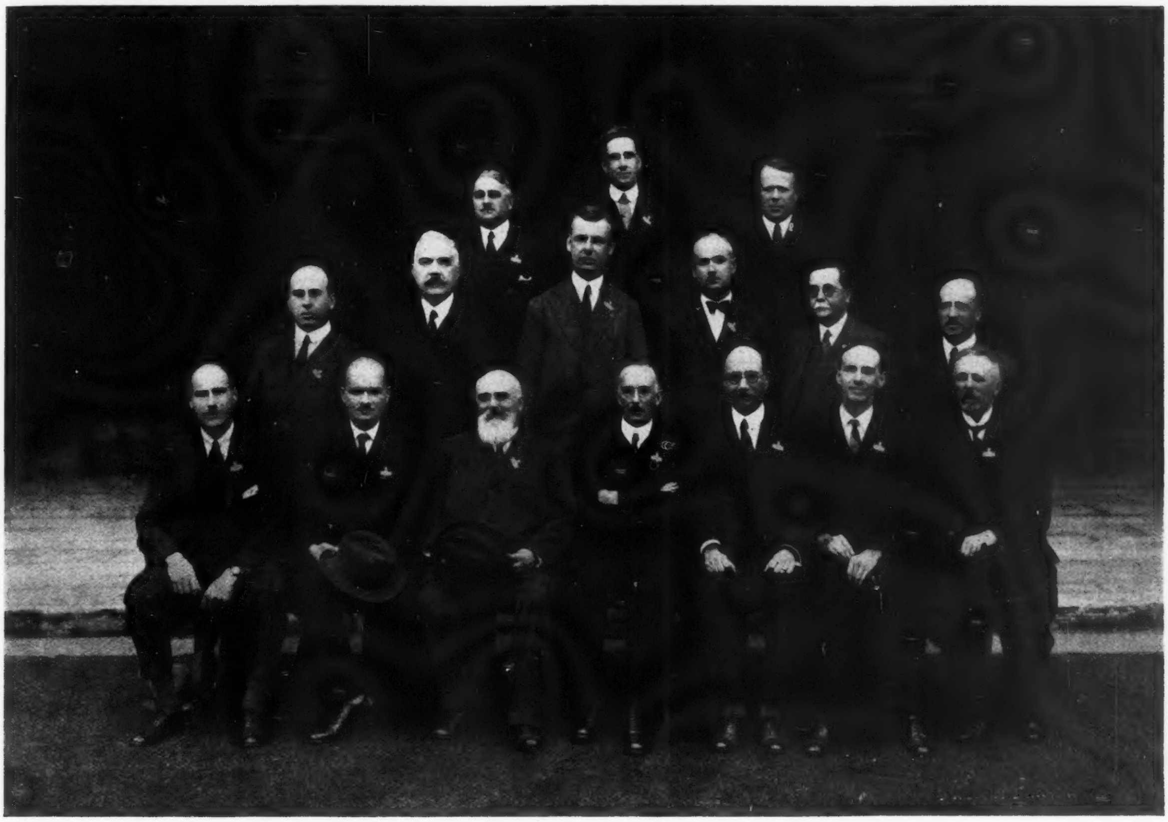
Mr. H. F. Buckley asked for more detailed information regarding the investigations on which the figures given were based, and pointed out that the R.A.C. Disc was more visible than the objects described in the paper. With respect to the figures for "glare" values he would also like to know how the percentage figures were ascertained. He approved of the values specified under the section dealing with "glare" but felt it would be of value to include the wattage and size of lamp. Monsieur H. Maisonneuve considered that for this subject the views of the police authorities must be considered before international agreement could be secured for this purpose and until this is achieved technical definition will be valueless for international work; he also stated that France recognizes that no final convenient form of motor vehicle driving lights has yet been evolved; he also pointed out that dew effects on the mirrors would notably affect results and might, at times, warrant special consideration. Mr. P. D. Morgan said that a common-sense view must be found and the technical details might be omitted as the object attained should have unanimous approval and be unfettered by local prejudices or customs. As regards "glare," there were two effective ways of dealing with this, diminishing the brightness of the source and varying its direction, but when using the bright lights necessary for modern speed traffic the treatment must inevitably be a compromise, and means must always be available for intermitting the brightest light. Mr. M. G. Bennet considered 35 watts inadequate for head-light lamps. Mr. Atherton approved of the rating of the light-source being in candle-power, as mentioned by Dr. Born, owing to the diversity of the ways of specifying lamps such as watts, amperes, lumens. Col. K. Edgcumbe enquired if a definite illumination would render a small object visible as stated in Dr. Born's theory: in his experience one easily observed the hand signals but not the often "invisible" bicyclist; he considered the illumination of 1 lux at 100 metres inadequate. In his response Dr. Born welcomed the suggestions made by Mr. Stickney, which he trusted would initiate consideration of this important matter in all countries. With regard to the size of objects and the necessary illumination, globes of different sizes had been tried and the illumination of 1 lux at 100 metres had proved quite adequate, as at that distance only a general view was needed as the small objects only came into consideration when closer at hand.

The interesting paper by Mr. A. Monnier, read in his absence by Monsieur A. Marsat, on "*French-made Electric Lamps for Use in Motor-vehicle Work and their Standardization*," being in the nature of a report of accomplished facts did not provoke much discussion but Col. K. Edgcumbe emphasized the importance of standardization on two definite voltages and also simplification and standardization of lamp caps so that international accommodation was available.

The contribution by Monsieur Roge on "*Recent Improvements in Electric Lanterns for Motor Vehicles*" in addition to being a record of the French-made lanterns, at the present time, embodied a strong plea for standardization of the essential parts of these important accessories to motor vehicles. In the discussion Mr. G. H. Stickney pointed out the necessity of having easily replaceable doors and absolute dust-proofness in the lanterns with means of securing reliable steady focussing of the lamp as well as stability in the holder, and in this connection approved of the three-pin lamp-holder due to its supporting the lamp on a tripod instead of uncertainly balanced on two supports in line. He stated trouble, which had at one time arisen from the emanation of sulphur from the sealing materials causing discolouration of the mirrors, had now become happily a thing of the past in all good makes of lanterns. Col. K. Edgcumbe emphasized the advantage of trimming lanterns from the back and the ease with which accurately shaped mirrors could be always attained with the certainty that a beam of correct constitution was available.

Light Traffic Signals, etc.

Other series of papers dealt with allied problems. Thus there were four contributions from Japan describing the various forms of coloured-light signals in use on the Japanese railways and reporting experience with selenium ruby and other coloured glasses.



[*Photo: Hill & Saunders, Cambridge.*

A Group of Heads of Delegations to the Session of the International Commission on Illumination (held in Cambridge during September 14th-19th. *Top row* (left to right): Signor C. Clerici (Italy), Dr. J. W. T. Walsh (Hon. Secretary), Mr. I. Folckre (Sweden). *Centre row*: Mr. A. M. Baidaff (Argentine), Mr. A. F. Enstrom (President, I.E.C.), Dr. N. A. Halbertsma (Holland), Mr. Rihanek (Czechoslovakia), Dr. R. Hiecke (Austria), Mr. T. Czaplicki (Poland). *Front row*: Col. K. Edgcumbe (Great Britain), Dr. W. Dziobek (Germany), Prof. H. Abraham (France), Mr. Clifford C. Paterson (President), Mr. A. Filliol (Switzerland), Mr. E. C. Crittenden (U.S.A.), M. de le Paulle (Belgium).

Informative papers dealing with *Light Traffic Signals* were presented by Mr. A. V. Blake and Dr. W. M. Hampton (Great Britain) and by Herr E. Schuppan (Germany). The former traced the historical development of this form of traffic control, mentioning the report of the Royal Commission on Transport which in 1929 reported in favour of their use. Investigations followed and in September, 1929, the Ministry of Transport issued a memorandum laying down principles governing standardization throughout the country, which the authors summarized. The distinction between the "limited progressive" and "flexible progressive" systems was explained and some. the duration of periods and cycles, were briefly analysed. "Red" and "green" exposures must be expected to vary according to local conditions, but for the "orange" a minimum period of 4.4 seconds is suggested. The desirable distribution of light, the avoidance of phantom indications and other problems were also discussed. Herr E. Schuppan's paper contained a practical survey of traffic regulation in Berlin, in the course of which the length of cycles and the nature of automatic controllers were considered. It is considered that, as a result of the introduction of traffic signals, 20 per cent. more traffic can be carried by the same streets in Berlin, and with considerably less hindrance.

Lighthouses were dealt with in a comprehensive paper by Mr. J. P. Bowen, Engineer in Chief, Trinity House, who introduced his subject by a brief but interesting historical survey. It is noteworthy that in lighthouses almost all illuminants have been, and to a great extent still are, made use of, as well as simultaneous audible signals and warnings. The author traced the successive stages in the design of lens systems for lighthouses and gave some description of procedure in connection with buoys and lightships.

Other sections at Birmingham dealt with "*Light Distribution*" and "*Heterochromatic Photometry*." In the former section four papers, devoted chiefly to processes of obtaining polar curves and simplifying calculations were presented. In the section on heterochromatic photometry the chief item was a statistical survey by Messrs. B. P. Dudding, G. T. Winch and B. S. Cooper showing the variation from normal between observers using direct and spectrophotometric methods, and the agreement attained between the two methods.

Sheffield Illumination Society

The Sheffield Illumination Society resumed its meetings on October 12th when a discussion on street-lighting topics by its members took place. The meeting was held in the new premises of the Corporation Lighting Department at Matthew Street. Prior to the discussion the members made a complete tour of the premises. The photometric laboratory, where the testing of electric lamps and gas burners, etc., is carried out, proved of particular interest. Mr. J. Styring (President of the Society), who presided, emphasized the value of these meetings of members in order to discuss technical problems associated with street lighting. We have no doubt that the formation of the Society has been of considerable benefit to its members, and we believe that this has invariably been the case where public lighting departments have had the enterprise to arrange periodical meetings of the staff.

The Eighth Session of the International Commission on Illumination, Cambridge, September 14—19, 1931

Trinity College.

IT was surely a stroke of genius on the part of those responsible for the organization of the just completed session of the I.C.I. to choose for its locale one of the oldest universities in the world and, moreover, that one which has so greatly contributed to the advancement of science in both pre- and post-Newtonian days. They did not rest content with this, moreover, but, by the kindness of the Master and Council of Trinity College the members of the Commission were enabled to hold their meetings, to take meals and (in many cases) to live for the whole period of the session within the precints of the college which boasts among its alumni Francis Bacon, Isaac Newton and many others whose names are familiar to us all, ending with its present world-famed Master, Sir Joseph Thompson.

There can be no doubt that all those who took part in the work of the Commission, and certainly not least those delegates who came from overseas, appreciated most highly the privileges accorded them, and even if it was something of a shock to some, who were previously unaware of the fact, to find that undergraduates' quarters are not quite as luxurious as those to be obtained in the first-class hotels of Paris or New York (the only example of "running water" to be found was the fountain in the centre of the Great Court), that was all part of the novelty of the thing. To not a few of the delegates, on the other hand, 10, 20, 30 (aye, and even 40) years rolled away and it was interesting to find that Mr. A. P. Trotter, whom all illuminating engineers know so well, stayed in the very same rooms that he occupied when an undergraduate at Trinity in 18--, well, we *did* have the other two figures given to us in confidence, but we will not infringe the copyright of the Cambridge University Calendar in this interesting item of information.

The technical meetings were held in some of the lecture rooms of the college, while the Old Combination Room was a delightful rendezvous for the general sessions. The opening plenary session, however, was held in the Guildhall, immediately after the Mayor's address of welcome. This was given on Monday morning, the 14th September, and was attended by practically all the delegates in Cambridge at that time.

The Civic Welcome.

The Mayor of Cambridge, who was supported by the Aldermen and Council, gave the Commission a very cordial welcome to the town. He said that Cambridge was always glad to have in its midst conferences and meetings of technical and other organizations working for the general welfare. He paid a tribute to the benefits of good lighting in general and to the beauties of floodlighting in particular. In passing, he expressed the hope that the greatly improved street lighting which had been installed in Cambridge to welcome the Commission might be allowed to remain as a permanent memento of its visit.

The President of the Commission (Mr. C. C. Paterson) responded on behalf of the delegates. He said that the object of the lighting engineer was not to turn night into day but to give to night a beauty all its own. The Mayor and Councillors then withdrew and the first plenary session followed immediately.

The Social Programme.

Before, however, we pass to a description of the technical work done at the meetings, we must devote a few lines to the social part of the programme which was so ably organized by a local committee under the chairmanship of Mr. L. B. W. Jolley. On the Sunday evening all the delegates and ladies listened to a delightful talk on Cambridge given by Mr. P. C. Fitzgerald, whose evident knowledge of his subject was only equalled by the delightful manner of its presentation.

On Monday, an official reception and dance were given at the New Dorothy Café, by the kind invitation of the Directors of the Cambridge University and Town Gas Light Company and the Cambridge Electric Supply Company Ltd. This was a most enjoyable evening and it was rendered still more pleasant by a little ceremony performed by Mr. Paterson who, on behalf of all the delegates to the Congress, presented Col. C. H. S. Evans, the Hon. Secretary, with a souvenir in the form of a gold watch. It may not be out of place to mention here that all the arrangements for accommodation in Cambridge were carried out by the Congress organization under Col. Evans' guidance.

On Tuesday, the ladies of the party had a most delightful day's outing. They left Cambridge at an early hour, taking motor launches to Ely where, after lunch, they visited the Cathedral and other historic buildings. After tea they travelled by motor-coach to Peterborough, where they were joined by a number of the delegates who had been attending the technical meetings and who travelled direct from Cambridge to Peterborough by motor-coach. After supper the whole party visited the Cathedral and greatly admired the lighting which had recently been installed.

The Wednesday afternoon in the Commission's week of meetings has always been treated as a "half-holiday." No technical sessions were arranged but intsead delegates were invited to join in one or more tours of technical interest. For instance, the various University laboratories, particularly the engineering laboratory, the world-famous Cavendish and the psychological laboratory, were all open to inspection, and parties were made up to visit the works of the Cambridge Instrument Company, the well-known makers of scientific instruments of all kinds.

In the evening, a large number of delegates and ladies assembled in the Hall of Trinity College to hear Sir Arthur Eddington give an address on "The Light of the Stars." He told of the various deductions which had been made concerning the nature and properties of the universe, and these deductions were based on the facts revealed by the light reaching the earth from the stars. Sir Arthur is always a good lecturer, and on this occasion those who had looked forward to an interesting hour were in no way disappointed. His remarks, too, were illustrated with some really fine slides of celestial objects. The one slight blemish was due, not to the lecturer, but to the very poor acoustic properties of the hall. Although a public address system had been installed, the lecturer had frequently to desert the microphone in order to point out some object on the screen. The result was occasionally somewhat tantalising to those who were not fortunate enough to be sufficiently close to the lecturer to be able to dispense with the amplification system.

On Thursday the ladies (and, it must be confessed, some of the delegates who were not specially concerned in the technical programme of this period) visited the factories, farms and orchards

of Messrs. Chivers & Sons at Histon. A great deal of interest was displayed in the various processes and in the supplementary industries connected with the primary one of jam-making.

Thursday evening was the occasion of the R.A.C. demonstration on Midsummer Common. This was similar to the demonstrations which the R.A.C. has arranged in Richmond Park in previous years. Inventors of devices for the reduction of dazzle were invited to bring cars fitted with these devices, so that they could be examined under actual driving conditions. On this occasion, headlights intended to comply with the draft regulations of the Ministry of Transport were also shown, and some 80 or more devices of various kinds were on exhibition. The demonstration was attended by many of the Commission delegates, who displayed a great deal of interest in some of the ingenious inventions shown.

Friday, the 18th, was the last day for technical meetings, and delegates were very busy in the morning; the afternoon was less strenuous, as by then nearly all the work had been completed, and resolutions were being prepared and translated in readiness for the final plenary session.

The ladies paid an all-day visit to Letchworth Garden City, and saw the many interesting industries carried on there. They were entertained to tea at the Letchworth Hall Hotel by the Directors of the Garden City.

It is impossible to conclude this brief account of the social side of the Commission's work without paying a tribute to the work of the Ladies' Committee, which, under the chairmanship of Mrs. R. C. Pierce, was so active in looking after the well-being (as well as the entertainment) of all the ladies accompanying the delegates to Cambridge. Nothing seemed to be too large for them to tackle, and, on the other hand, nothing was too small to engage their attention. On all sides one heard nothing but the highest praise and the heartiest appreciation of their energy, their infinite patience and unfailing tact.

The Technical Meetings.

We must now turn to a brief description of the more serious business of the week, viz., the technical meetings, and the decisions arrived at as a result of the discussions which took place.

The opening plenary session was held in the Guildhall immediately after the official welcome by the Mayor and Corporation. The President, in his introductory address, paid tribute to the members deceased since the meeting at Saranac Inn, among them Prof. Vautier, who was President of the International Photometric Commission from the time of its foundation in 1901, and who continued to act as President of the I.C.I. until 1924. Mr. Paterson referred to the great increase in the attention paid to lighting matters, a marked feature of the last three years, and he paid a tribute to the work of the Lighting Service Bureaux in furthering this interest. He also mentioned the various matters of policy which would have to be dealt with during the Cambridge session, among them being the inclusion of ultra-violet light within the programme of work, and the establishment of as close a liaison as possible with the Comité International des Poids et Mesures at Sèvres, now that this body had expressed its intention of including photometric units and standards in its terms of reference.

Finally, the President said that proposals had been made for a reorganization of the Commission's technical work, the establishment of fresh international committees charged with the study of further technical matters, and the redistribution of secretariat duties for the various technical committees among the nations now supporting the Commission's work. A special sub-committee was appointed to draw up a scheme for submission to the final plenary session, and this is reproduced at the end of this article.

In the afternoon, three technical sessions were held concurrently in different rooms. In one of these the subject dealt with was *Street Lighting*, and most of the time was devoted to a discussion of the answers to a questionnaire circulated (at the request of the U.S. National Committee) by the secretariat committee (Germany); the report of the secretariat was left over for the second meeting on the Friday.

At the meeting on *Daylight* the secretariat (British) committee's report was discussed at some length, and the proposals put forward by the British delegates on behalf of the National Committee were finally adopted in the following form: It was recommended (*a*) that contour lines of constant daylight factor (iso-daylight factor lines) should be used in the study of the daylight conditions in rooms, and (*b*) that all parts of interiors where the daylight factor is less than 0.2 per cent. should be regarded as having definitely inadequate daylight for work involving visual discrimination, such as writing. It was also recommended that National Committees should bring these resolutions to the notice of the architectural and medical organizations and the authorities responsible for framing building regulations in their respective countries.

The meeting of the committee on the photometric *Vocabulary* dealt with the inclusion of certain new terms and the arrangement and numbering of those already included. It was decided to make the vocabulary not simply a list of terms, but a technical dictionary of the subject in English, French, German, Italian and Spanish.

Tuesday morning was an exceptionally busy half-day as no less than four technical sessions were held concurrently. The first dealt with the somewhat diffuse subject of *Applied Lighting Practice*. Discussion centred round the replies to the questionnaire which had been circulated to all countries by the United States Committee (Secretariat). This covered advertising practice (by signs and posters), shop lighting, floodlighting, and the lighting of clerical offices and drawing offices, much detailed information being asked for in each of these different categories. The opinion was expressed at the meeting (and a resolution to this effect was passed) that the questionnaire sent out contained a large number of questions which could only be answered with a reasonable degree of accuracy after making an extensive survey, and that as, in most cases, time, facilities and means seemed to have been lacking for making such surveys, the data contained in the Report could have only a limited value. It was proposed that in future the scope of such questionnaires should be limited to such questions as had been considered and approved before circulation.

At the meeting on *Coloured Glasses for Light Signals* a very interesting discussion took place on methods of selection and on the tests to be applied to signal glasses. It was agreed that the desirabliity of specifying the transmittance rather than the transmission* of signal glasses and lenses should be carefully considered.

* The "transmittance" of a transparent medium is defined as the ratio of the light which reaches the second surface of the medium (before passing through that surface) to the light which passes through the first surface. Thus, while the "transmission" factor of a medium includes losses due to reflections at the surfaces, the "transmittance" as defined above, does not and it is therefore more truly a property of the medium itself.

The committee on *Definitions and Symbols* added to the list of approved symbols the letter n to represent refractive index. Hitherto both n and μ have been widely used. It also proposed to add a new term to represent the quantity which arises when defining the impression produced by a "point" source of light viewed from a distance. The French term proposed was "éclat stellaire," expressed as the illumination (in microlux, or 10^{-7} foot-candles) produced by the source at the observer's eye. Thus a motor-car headlight with an equivalent candle-power of 10,000 when viewed at a distance of 10 kilometres would have an "éclat stellaire" of $10{,}000/(10{,}000)^2 = 0.0001$ lux = 100 microlux. No suitable name in English or German was proposed.

A further recommendation of this committee was that authors should give, in addition to figures expressed in national units, the equivalents in c.g.s. units. In the case of illumination values, however, the lux (lumen per square metre), which is one ten-thousandth of the c.g.s. unit, may be used.

The report of the secretariat committee on *Photometric Test Plates*, the Austrian National Committee, dealt with the characteristics of the materials used for the test plates of portable illumination photometers. As a result of the discussion it was recommended that further work on these materials should be carried out. The decision arrived at in 1928 as to the normal height for measuring illumination (85 cm.) was confirmed.

On Tuesday afternoon three meetings were held; that on *Traffic Signals* was well attended and a useful discussion resulted in the following decisions:—

(*a*) It was recommended that in future installations the arrangement of the colours should be:—

Red	at Left or Top
Amber (when used)	in Centre.
Green	at Right or Bottom.

(*b*) It was recommended that the lens diameter should not be less than 8 ins. and the lamp wattage not less than 60.

Fundamental research on *Glare* is an exceedingly difficult matter and progress must necessarily be slow. The discussion, to a large extent, centred round the manner in which experimental results might be most conveniently expressed. It was finally resolved that research workers on this subject should be invited to arrange their experiments so that the results were expressible in terms of equivalent background brightness.*

The third meeting dealt with *Cinema Lighting*. The report of the secretariat committee (Japan) gave a very full account of the conditions of auditorium lighting in the principal cinema theatres in Tokyo, but no very definite conclusions were reached as a result of the meeting.

It may be mentioned in passing that on the Tuesday afternoon a meeting was held by the committee of the International Electrotechnical Commission which deals with the standardization of screw lamp caps and sockets. It is understood that useful progress was made towards international agreement on this important matter.

On Wednesday morning, the 16th September, three more technical meetings were held. The first was very well attended and dealt with the subject of *Automobile Headlights*. A large number of proposals were put forward for agreement and a considerable proportion of these were adopted, the more important being (*a*) that the nominal range of a beam in any direction shall be taken as the distance at which the illumination produced on a vertical plane is 1 lux; (*b*) that a driving beam (for use on the open road) shall be such as to produce an illumination of between 1 and 25 lux at 100 metres ahead of the car; (*c*) that the use of coloured beams for driving in fog possesses no advantages.

The *Precision of Photometry* was a somewhat abstruse subject which, perhaps not unnaturally, led to a certain amount of misunderstanding at first, but this was cleared up during the discussion, and a useful exchange of experiences took place among those having first-hand knowledge of what was possible in every-day photometry. An illumination of the photometer screen of between 5 and 20 lux was recommended for accurate work.

In the meeting on *Light Flux Distribution* the British Committee put forward suggestions for the ready classification of the light distributions of fittings, as shown by their polar curves. There were other proposals, notably a very complete and elaborate system put forward by the Japanese Committee. After a general discussion it was agreed to recommend that in any such classification the terms indirect, semi-indirect, general or mixed, semi-direct, direct, should be used as far as possible.

Three very important meetings were held on Thursday morning. In the first of these, viz., that on *Lighting for Aerial Navigation*, a great deal of work of the utmost importance was carried out. This was continued at another meeting held later, and a number of recommendations were adopted. In the first place, a comprehensive list of terms was prepared in three languages (English, French and German), and each term was accompanied by the appropriate definition in English. The French and German definitions are to be added later.

With regard to boundary lights and obstruction lights, it was recommended that these should be distinguishable from each other, that the latter should be red (and, as far as possible, fixed) while the former could be either (i) orange, (ii) white, (iii) red and white mixed, or (iv) red (for existing lights only). In the future red is to be reserved for obstruction lights.

A number of recommendations were made with regard to landing lights, airport beacons and airway beacons. Other recommendations were made regarding navigation lights on aircraft, and these recommendations will be transmitted to the Congrès International de la Navigation Aerienne. For the voltages used for lighting on aircraft, it was agreed to admit 6, 12 and 24 as standard. The question of the standardization of lamp sockets was considered, and National Committees were asked to study this subject as well as a number of others, including visual performance under flying conditions, the effect of fog on the transmission of coloured light, and the wavelength limits of the different coloured lights required for aviation purposes.

The subject of *Heterochromatic Photometry* was considered at one of the meetings on Thursday. Discussion centred, to a large extent, round the use of the flicker photometer, and the methods most appropriate for the measurement of highly coloured light sources with discontinuous spectra, such as the gaseous discharge tubes now coming into common use. The conditions specified for the flicker photometer were (*a*) a two-degree field, (*b*) a brightness of $25/\pi$ candles per square metre (about 2.5 foot-candles on a white surface) and a bright surround.

It has long been felt that the subject of illumination does not receive its proper share of attention

* At any given field brightness a certain minimum difference of brightness is just perceptible by the normal observer, glare being absent. This difference necessarily increases as the field (or background) brightness increases. It also increases if glare be present. Hence the effect of a glare may be stated by giving the value of the "no-glare" field brightness at which the minimum perceptible brightness difference is the same as that actually found under the "glare" conditions studied.

in the courses of secondary schools and colleges, and at the meeting of the committee on *Lighting Education* attention was drawn to this defect, and national committees were urged to do all they could to remedy it. Further, they were asked to aim at the establishment in each country of *at least* one full course of illuminating engineering at a university or college of university standing, and to encourage authorities in charge of museums and exhibitions to include exhibits illustrating the value of good lighting.

Other recommendations made were (i) that there should be fuller opportunities afforded for the study of artificial illumination in all architectural colleges, and (ii) that public utility companies should include on their staffs technically trained men able to give to members of the public sound advice on lighting matters.

On Thursday afternoon a *General Session* was held in the Old Combination Room at Trinity College. The papers read dealt with standards of light and methods for establishing and maintaining the unit of candle-power. Mr. E. C. Crittenden read, on behalf of the representatives of the National Standardizing Laboratories, a statement of the progress made in arriving at an agreed method for bridging the colour step between the carbon-filament standard lamps and the sub-standards used in the photometry of modern light sources.

After the meeting of the Commission in 1927, four blue glasses were circulated among the national laboratories, and their transmission factors were measured by three methods: (*a*) direct comparison, using an ordinary Lummer-Brodhun photometer; (*b*) flicker photometry; and (*c*) spectro-photometry, using the I.C.I. visibility data. Although some additional measurements have yet to be made, the representatives of the national laboratories were able to arrive at agreement on the following points:—

(1) The spectro-photometric results are in general most concordant among themselves.
(2) The spectro-photometric method is certainly correct in principle, provided that the visibility factors have been properly determined.
(3) The agreement between the three methods is sufficiently close, so that no serious practical difficulty will arise from the use of the present visibility factors for measurements on sources of the type now in question.
(4) The laboratories will therefore accept the spectro-photometric method, and will proceed jointly to adjust the values of their standard lamps on this basis.
(5) This adjustment will make necessary some change in the candle-power values of lamps in all countries. This change will be arranged to take effect at some specified future date. If possible, it will be arranged to take effect at the same time as the change in electrical units, which is expected to be made within a few years, so that all the necessary changes in lamp data can be made at one time.

A proposal for a new form of primary standard was made by Prof. Ornstein, of Utrecht. He suggested that the standard should be based on accurately measured *energy* at agreed wavelengths, and the application of an agreed value for the mechanical equivalent of light.

The Dutch National Committee presented a very comprehensive report on ultra-violet radiation, and proposed that the Commission should extend its domain to cover the study of ultra-violet radiation, in so far as this radiation was emitted by light sources in regular use. At the final plenary session this proposal was accepted.

Friday was the last day of technical sessions. In the morning the second meeting on *Street Lighting* was held to consider the secretariat report. This dealt in turn with the matters included in the recommendations made at Saranac.

The discussion on the inclusion of minimum illumination, as well as average, was very prolonged, but finally it was agreed to recommend that, for international purposes, the information given regarding a street-lighting installation should include (*a*) a complete description of the luminaire, with its consumption of gas or electricity; (*b*) the spacing, height and transverse position of the luminaires; and (*c*) the average illumination accompanied by the figure of minimum illumination. It was also agreed to study the illumination of vertical surfaces on a street, and the reflection characteristics of road surfaces as far as they affected surface brightness.

The meeting on *Colorimetry* passed a number of highly technical resolutions. The first defines a "standard observer" whose eye is such as to follow the agreed I.C.I. visibility curve, and to obey certain relations which state that the combination of certain monochromatic stimuli in specified proportions shall produce a colour match with other specified stimuli. The exact values were not available at the meeting, but the resolution was left to be completed as a result of subsequent computation.

The second recommendation described three light sources suitable for colorimetric work, viz., (i) a gasfilled lamp operated at a colour temperature of 2848° K., (ii) and (iii) the same lamp with filters which convert the colour temperature to 4800° K. and 6500° K. respectively.

The third and fourth recommendations dealt with the colorimetry of opaque materials, and specified that the light should be incident at 45°, and that the surface should be viewed normally. The brightness of magnesium oxide under the same illumination was to be taken as unity.

Finally, it was recommended that the standard system of colour specification should be the trichromatic system, using as the four fundamental stimuli the three monochromatic stimuli 0.7000μ, 0.5461μ, 0.4358μ, and a specified standard illuminant.

The meeting on *Factory and School Lighting* endorsed the I.C.I. Code adopted at Geneva as far as actual minimum values were concerned, but it recommended that the values given in the secretariat report (to appear in the *Proceedings* of the session) should be accepted as indicating the illumination values which assure human welfare and which are justified economically.

Other recommendations were made, particularly as regards the study of the illumination values required for long-continued work and for workers with sub-normal vision.

On Friday afternoon only one technical meeting was held, viz., that dealing with *Diffusing Materials*. The different methods proposed for determining the diffusing properties of opal glasses were described and discussed, and it was recommended that these should be studied further by national committees. Especially it was recommended that careful consideration should be given to the proposal that the optical properties of glass intended for totally enclosed globes should be specified by the total transmission of a globe at a thickness giving a defined degree of visibility of the light source, provided that the thickness at this degree of visibility was equal to or greater than the figure needed for satisfactory mechanical strength.

The final *Plenary Session* was held in the Old Combination Room on Saturday morning. The first business was the formal approval of the various recommendations put forward and agreed at the technical sessions. With a few comparatively minor alterations, these were passed, it being pointed out that the decision was actually taken on the text of the recommendations in the French language, the English and German versions being subject to improvement at a later date.

The next business was the election of officers for the ensuing three years. As President, Vice-President Dr. A. Meyer (Germany) was proposed by Professor Abraham and was elected by acclamation. There were thus two vacancies among the vice-presidents, as M. Rouland retired by rotation. These vacancies were filled by the election of Dr. N. A. Halbertsma (Holland) and M. de le Paulle (Belgium). Both of these gentlemen had taken a very active share in the work of the session and their election to the office of Vice-President was agreed by acclamation. The position of Honorary Secretary was filled by the election of Mr. C. C. Paterson (Past President), the proposal of his name by Dr. Halbertsma being received with great enthusiasm. Equally, the re-election of M. Filliol as Honorary Treasurer was accepted by acclamation.

The Treasurer then presented the budget of the Commission for the period 1931-34 and proposed that the rate of contribution already in force should be continued.

The only other business remaining was to decide on the date and place of the next Session. On behalf of the German delegation, Dr. W. Dziobek extended to the Commission a hearty welcome to hold its ninth Session in Germany in 1934. This invitation was accepted with the greatest enthusiasm and there is no doubt that it will not be long before National Committees start active work in preparation for the next Session.

General Impressions.

In conclusion, a few words may not be out of place to record the impressions left on the mind of a delegate who has attended every Session of the Commission held since 1921.

There is first of all the realization of the extraordinary way in which the Commission's work has expanded and of the way in which it has now become necessary to specialize, not in illuminating engineering as a whole, but in *one branch* (or at most a few branches) of illuminating engineering.

Next there is the feeling that each Session carries on its work in an even more friendly spirit than the last. Always, it is the *progress of the subject in hand* that transcends all other considerations. Personal and even national prejudices are swept aside in a combined effort for the common good and in the adoption of the long-sighted view.

Then as regards the actual progress made, it is inevitable that this should be very different in the different subjects. One subject will rapidly assume very great practical importance, progress will be rapid, and then it will sink more or less into the background while another "young" subject pushes forward into the limelight. For this reason the Commission must be ever on the watch to adjust and modify its programme to meet current needs. In so far as it does this, its value to industry and to mankind at large will become greater with the passing of the years and each Session will excel the one before it in enthusiasm, in productivity and in the achievement of its mission to encourage the application of light to further human happiness and minister to human needs.

APPENDIX.

CLASSIFICATION OF SUBJECTS STUDIED BY THE I.C.I.

PHOTOMETRY AND VISION.

1. Vocabulary, definitions, symbols, systems of units.
2. Standards of light.
3. Unit of candle-power, international comparisons of standards of candle-power, of colour temperature, of reflection factors.
4. Vision and properties of the eye.
5. Visibility of light sources, glare, etc.
6. Methods of physical photometry, with and without colour difference.
7. Colour problems, colorimetry.

ILLUMINATION AND OTHER VISUAL APPLICATIONS.

21. Light sources (gas mantles, neon tubes, tungsten incandescent lamps, etc.).
22. Properties of materials and of apparatus used for lighting (reflection factors, properties of diffusing materials, distribution of light flux, etc.).
23. Exterior lighting for illumination purposes (street lighting, automobile headlights).
24. Interior lighting for illumination purposes (schools, factories, homes).
25. Lighting for decoration or advertisement, (shop-window-lighting, floodlighting, architectural lighting).
26. Lighting signals (aviation, railway, traffic control, etc.).
27. Daylight.
28. Shadows.

NON-VISUAL APPLICATIONS.

41. Invisible radiation from light sources.

MISCELLANEOUS.

61. Lighting legislation.
62. Lighting education, propaganda, practical applications, voltage and pressure variations.

LIST OF TECHNICAL COMMITTEES.

SWITZERLAND ...	1. (*a*) Vocabulary.
FRANCE	1. (*b*) Definitions.
	2. Light standards. Specification of the black-body. Specification of an energy standard, using the mechanical equivalent of light and the visibility factors.
	3. Units of candle-power and intercomparisons of lamps at different colours.
GREAT BRITAIN ...	4. Glare. Method of determining it in street-lighting.
HUNGARY	5. (*a*) Development of definition of a practical method for the photometry of discharge tubes.
CZECHOSLOVAKIA ...	5. (*b*) Photometry. Extension of the table of probable accuracy: (*a*) to flux measurement, (*b*) to measurement in the field.
POLAND	5. (*c*) Photometry test plates. Study of reflection characteristics and selectivity.
FRANCE	6. Physical photometry with photo-electric cells.
GERMANY	7. Colorimetry. Colour definition.
GERMANY	22. (*a*) Diffusing materials, their characteristics and classification.
AUSTRIA	22. (*b*) Light-flux distribution and its classification.
HOLLAND	23. (*a*) Street lighting.
BELGIUM	23. (*b*) Automobile headlights. Specification of beams and of lamps.
U.S.A.	24. Factory and school lighting.
FRANCE	25. (*a*) Architectural lighting.
GREAT BRITAIN ...	26. (*a*) Aviation lighting. Ground lighting. Specification of light sources at aerodromes, and on flying routes.
U.S.A.	26. (*b*) Aviation lighting. Specification of light sources on the airplane.
GREAT BRITAIN ...	26. (*c*) Traffic control signals.
JAPAN	26. (*d*) Coloured glasses for signals. Colour definition. Specification and method of measurement.
SWEDEN	27. Daylight. Artificial daylight. Special glasses.
GERMANY	28. Shadows. Methods of measurement.
GREAT BRITAIN ...	29. Lighting of mines.
HOLLAND	41. Ultra-violet radiation.
U.S.A.	61. (*a*) Lighting education.
SWITZERLAND ...	61. (*b*) Lighting practice and applications.
ITALY	61. (*c*) Voltage variations. Study of existing conditions and of means for improvement.

Progress in Illuminating Engineering

THE opening meeting of the Illuminating Engineering Society took place at the E.L.M.A. Lighting Service Bureau (15, Savoy Street, Strand, London, W.C.) at 6-30 p.m., on Tuesday, October 20th, when Lt.-Col. K. EDGECUMBE (Past President) took the Chair.

After the minutes of the last meeting had been taken as read, the Hon. Secretary announced the names of new applicants for membership, which were as follows:—

Corporate Members :—

Botten, A. W. ....Engineer, Queen Street Place, Dartford, Kent.

Cogni, E. M. F. ....Managing Director Electrolumination (Aradie Process) Ltd., 21, Soho Square, W.1.

Curry, J. C. ....Technical Assistant, Lamp Sales Dept., British Thomson-Houston Co. Ltd., 143, Lynton Road, Acton, London, W.3.

Miller, F. E. C. ....Assistant London Manager of the Edison Swan Electric Co. Ltd., 155, Charing Cross Road, W.C.2.

Morgan, P. D. ....Electrical Engineer, Senior Technical Assistant to the British Electrical and Allied Industries Research Association, 36, Kingsway, London, W.C.2.

Randall, A. L. ....Technical Engineer and Designer, 24A, Avondale Road, London, N.13.

Associate :—

Kennedy, Miss Joan B., Junior Assistant at the E.L.M.A. Lighting Service Bureau, 15, Savoy Street, Strand, W.C.2.

Country and Foreign Members. :—

Algar, F. X. ....Engineer in Charge, Public Lighting Dept. Electricity Supply Board, 4, Beaufort Villas, Rathfarnham, Dublin.

Bryant, E. C. ....Illuminating Engineer, Edison Swan Electric Co. Ltd., Newcastle.

Lennox, E. C. ....Electrical Engineer, Newcastle-on-Tyne Electricity Supply Co.

Wodskou, S. P. ....Electrical Engineer, Vesterbrogade, 137, Copenhagen, V., Denmark.

The names of applicants presented at the last meeting* were read again and these gentlemen were formally declared members of the Society.

AWARD OF LEON GASTER MEMORIAL PREMIUM.

The CHAIRMAN then announced that the Council had unanimously decided to award the Leon Gaster Memorial Premium for the past sesssion to Mr. H. T. YOUNG for his paper on "Modern Domestic Lighting." (It may be recalled that this fund has only recently been completed so that the above is the first award of the premium that has yet been made.)

The premium, accompanied by a certificate on vellum recording the award, was then presented to Mr. Young amidst general applause.

REPORT ON PROGRESS.

Mr. A. W. Beuttell, the Chairman of the Technical Committee, then presented the usual Report on Progress for the past year, which again contained an informative record of advances in many different fields of lighting, though no very outstanding discoveries were recorded.

The report was a comprehensive one and was a creditable production, especially when one recalls that those responsible for its compilation had almost all been occupied with the International Illumination Congress throughout the previous months.

EXHIBITS ILLUSTRATING PROGRESS IN ILLUMINATING ENGINEERING.

Under this heading there were nine different items which, as usual, were of a varied nature. Dr. J. W. T. WALSH exhibited a novel form of "Daylight Integrator" developed at the National Physical Laboratory. Mr. P. J. WALDRAM had two exhibits, a device for enabling the period of access of direct sunlight into interiors to be determined, and a very compact instrument enabling the daylight factor to be ascertained. Mr. L. E. BUCKELL illustrated two new developments in electric lamps: the "coiled-coil" filament and the "sunlight" lamp, combining incandescent radiation with the ultra-violet rays from luminescent mercury. Another form of sunshine lamp utilizing an incandescent lamp and a mercury-vapour lamp within a vitreosil lamp was shown by Mr. ROBERTS. Dr. LEONARD LEVY was responsible for some very pleasing demonstrations of posters using fluorescent materials excited by ultra-violet rays, Mr. H. H. LONG exhibited the new "Duoflux" projector and other lighting accessories, Mr. R. C. HAWKINS briefly described the lighting equipment on the Manchester-Altrincham railway and Mr. S. L. CALVERT showed a new form of sign based on the display of letters silhouetted against a luminous colour-changing background.

A vote of thanks to the authors and exhibitors and to the E.L.M.A. Lighting Service Bureau for their hospitality, terminated the proceedings.

(The Report of Progress and an illustrated account of these exhibits will appear in our next number.—Ed.)

* *The Illuminating Engineer,* June, 1931, p. 124.

Public Lighting Superintendents

THE MANCHESTER APPOINTMENT.

Readers will recall that in our last issue we referred to the fact that the city of Manchester was inviting applications for the position of lighting superintendent. We are now informed that the Paving Committee of that Council has appointed Mr. James Sellars, who recently took up duty in Nottingham, and who is a member of the Association of Public Lighting Engineers.

We may recall, also, that in commenting on this appointment we urged that in such a city as Manchester (where the expenditure on public lighting is of the order of £200,000) it is of vital importance to secure an efficient and qualified engineer in sole charge of the public lighting—specially assigned to this duty and not subordinate to other departments.

The Lighting Superintendent has, however, been appointed under the City Engineer, and one assumes that he may still be required to undertake duties quite dissociated from those involved in the supervision of public lighting.

We understand that two prominent members of the A.P.L.E., Mr. J. F. Colquhoun, of Sheffield, and Mr. Thomas Wilkie, of Leicester, after making their protest before the Paving Committee when the short list of applicants was being dealt with, found themselves unable to consider the Manchester appointment and the consequent loss of status under these conditions. They accordingly withdrew from the contest.

It is a great disappointment to learn that the efforts made by Mr. Colquhoun and Mr. Wilkie and likewise the attempt both of the A.P.L.E. and of this its official journal have failed to convince the city of Manchester of the inexpediency of this course. We can only hope that in the future, when there has been time to review the position and consider the results of more progressive action in other cities, wiser counsels may prevail.

Meantime the city of Manchester has lost the services of two past-presidents of the Association of Public Lighting Engineers, whose firm stand for a vital principle may be commended to the notice of other members.

Some Remarks on the Spread of Light-beams and the Measurement of Beam-flux

By J. BERGMANS and H. A. E. KEITZ,

Illuminating Engineering Laboratory of N. V. Philips, Gloeilampenfabrieken, Eindhoven.

MANUFACTURERS of projectors generally state a certain angle for the "spread of the beam." In many cases they also state the luminous flux ("beam-lumens") emanating from the projectors, this value being intended to indicate the efficiency and to aid the designer of floodlight installations in his calculations.

It is obvious that the efficiency calculated as the ratio between flux emanating from the projector and flux produced by the source is of little use in judging the quality of a projector. As a rule, it is more important to know what luminous flux may practically be considered as belonging to the beam. If, therefore, one wishes to rate the beams of projector in simple terms, one can express the spread of the beam by one or more angles if the luminous flux radiated in the corresponding solid angle is simultaneously indicated.

What part of the flux radiated by the projector may be considered as "belonging to the beam"? There are only a few rules proposed for determining this, and no international agreement has as yet been arrived at on the subject.

F. A. Benford proposed in 1923*:—

"A rule of practice has been adopted by nearly all photometrists, and by use for a number of years has acquired something of the sanctity of age. This rule may be stated: The width of a projected beam-light is measured between points on a diameter that have an intensity of 10 per cent. of the maximum intensity."

In many catalogues for projectors this 10 per cent. intensity limit has been adopted. The "Leitsätze"† of the "Deutsche Beleuchtungstechnische Gesellschaft," adopted in the annual meeting at Jena of September, 1924, make a distinction between the spread for long-distance work and the spread for short-distance work.

The spread for short-distance work is defined by fixing the beam-limit at 10 per cent. of the maximum luminous intensity in agreement with the rule adopted by Benford, and by practically all those who have published measurements of beam-lights. For long distances, however, the spread is defined by taking 50 per cent. of the maximum luminous intensity as a limit. Nothing is stated about the meaning of "long distance" and "short distance."

These differences point to the great difficulties in arriving at a sound definition. They are, in the first place, due to the fact that the luminous intensity in the beam gradually decreases from the maximum value to zero, and does not show at any one point a drop in intensity corresponding to the apparent drop observed by our eyes. What the eye considers to be the limit of a beam largely depends upon circumstances, such as the brightness of the illuminated object, its contrast with the background, the place from which the illuminated object is observed.

In order to form an opinion regarding the physiological effect of certain beams and to test in practice the above-mentioned rules for measuring the spread of the beam, we have carried out some experiments in which we examined under various conditions the physiological impression of objects illuminated by a projector. The observations were made by five persons whose judgment differed but slightly.

For these experiments a Philips "Philiflood" beam-light (type Fl.C2) was used, with a "searchlight" lamp of 220 volts, 1,000 watts. Fig. 1 gives the horizontal light-distribution curve of the projector used.

In order to eliminate as far as possible the trouble due to intense illumination of the foreground, the unit was in some cases mounted on a motor lorry (about 3 metres above the ground).

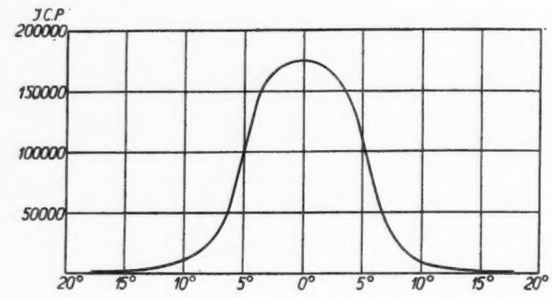


FIG 1

In order to direct the centre of the beam, the projector was fitted with a sight.

1. A house with a white façade was floodlighted (see Fig. 2) at a distance of 60 metres (breadth of façade 8.50 metres, height to top of roof about 8 metres).

FIG. 2.

The beam was first directed with the centre on to the left-hand boundary line of the façade. When viewed from a point about 1 metre behind the beam-light (A in Fig. 3) the spot of light seemed to decrease fairly rapidly in intensity, and the boundary of the beam seemed to be at 7 metres from the central axis of the beam.

However, when the façade was viewed from points B and C respectively, the illumination conveyed two totally different impressions to the observer.

* *Gen. El. Rev.*, *26*, 280, 1923.

† *Li. u. La.*, *13*, 425, 1924; *E.T.Z.*, *45*, 1,318, 1924; Ill. *Eng.*, *17*, 111, 1924.

When viewed from B, the illumination of the façade appeared even less uniform than when viewed from point A.

From point C, on the other hand, the façade appeared to be fairly uniformly illuminated, and the observer would certainly never have assumed that the boundary of the beam was $1\frac{1}{2}$ metres away from the right-hand boundary of the façade. The façade as a whole presented the appearance of being uniformly illuminated.

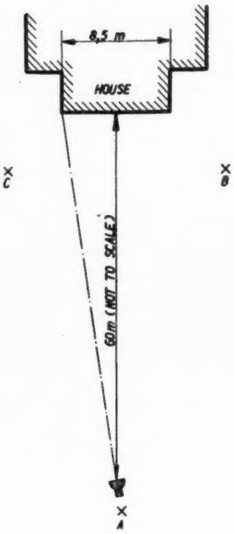


FIG.3

This phenomenon can be accounted for by the fact that the right-hand boundary line of the façade stood out very prominently against the dark background, whereas the left-hand boundary line, although illuminated still more intensely, did not show such a vivid contrast to the environment (part of the light also fell on the side-wings of the house). So, when observing from C, the contrast of the right-hand boundary line of the façade against the dark background was so great that it made disappear the contrast between the various parts of the façade, which, really, were within and beyond the beam-limit as defined by 10 per cent.

On the other hand, when viewed from B, the contrast of the left-hand boundary line of the façade against the dark background was so much more pronounced and the contrast of the right-hand boundary line against the not quite dark environment so much less pronounced (because here, too, small side-wings of the house were illuminated as well) that the lack of uniformity appeared to be accentuated.

A spread of 7 metres at a distance of 60 metres, according to Fig 1 corresponds to 40 per cent. of the maximum luminous intensity, a spread of 8.50 metres to 16 per cent. of the maximum luminous intensity.

2. The projector was then mounted on a football field at a distance of 138 metres from a row of trees, in one case at about 3 metres above the ground and in another case only 0.5 metre above the ground (Fig. 4). In the first case the beam reached the ground only at a great distance; in the second case it reached the ground directly in front of the beam-light, thus creating in the field of vision an area with a relatively high brightness, which resulted in a different adaptation of the eye.

With the projector about 3 metres above the ground, the boundary of the beam was estimated to be situated at the place of 8 per cent. of the maximum luminous intensity; in the second case at about 16 per cent. of the maximum luminous intensity. In both cases the observers were standing at about the same position as the beam-light (Fig. 5, point A).

It was remarkable that when the observer moved from A to B (25 metres to the right of the projector), the right-hand boundary of the beam, as seen by the observer, seemed to have moved to the right, whereas the left-hand boundary remained at the same place. When the observer moved to point C, the same phenomenon occurred in an opposite sense.

We want to explain this phenomenon by the fact that at B the eye viewing the left-hand boundary has to adapt itself to the brightly illuminated foreground, whereas for the right-hand boundary it adapts itself in another way, owing to the dark foreground.

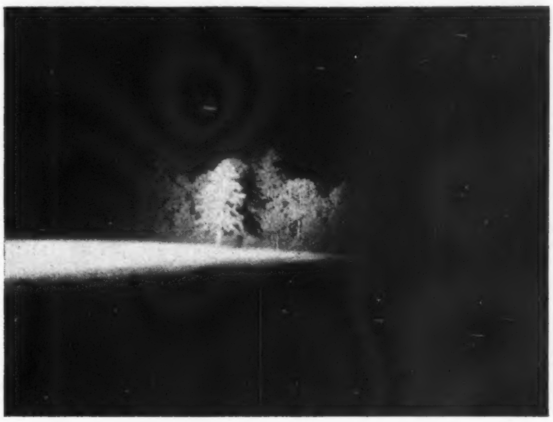


FIG. 4.

A certain amount of specular reflection on the leaves of the trees may also have some influence.

When the observer moved to D, E and F, he perceived on both sides practically the same area of beam as had been observed from B on the right side of the beam and from C on the left side.

3. The projector (again mounted about 3 metres above the ground, at a distance of 38 metres) was directed on a church of fairly bright brickwork (Fig. 6).

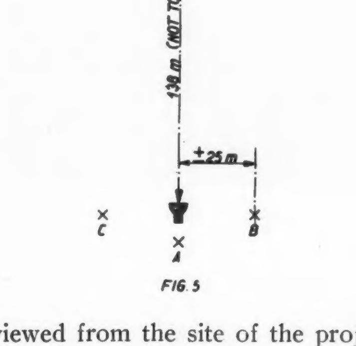


FIG.5

When viewed from the site of the projector, the apparent boundary of the beam was found to be at 8 per cent. of the maximum candle-power. The boundary of the beam as seen on the wall was practically a circle. When the beam was directed on to

the tower adjoining the church, so that the wall was only partly illuminated, the boundary of the beam-spot distinctly differed from the circular shape.

At the edge of the roof (Fig. 7, P) the beam appeared to be larger, probably because the contrast between the brightly illuminated wall and the dark

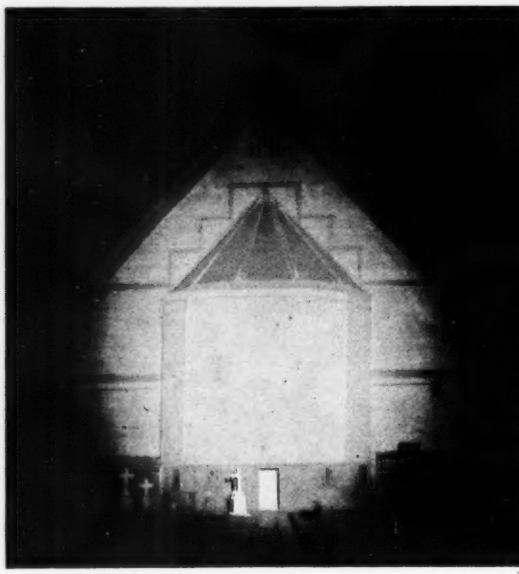


FIG. 6.

sky rendered the wall brighter at that spot to the eye of the observer. This will, of course, not show on the photograph.

If we now consider the results of these experiments, the first thing that strikes is that when observing the white house at a *short* distance (60 metres) we arrive at a *higher* percentage (40 per cent.) for the boundary of the beam than was the case when observing the trees at a *longer* distance (140 metres; 8 per cent. and 18 per cent).

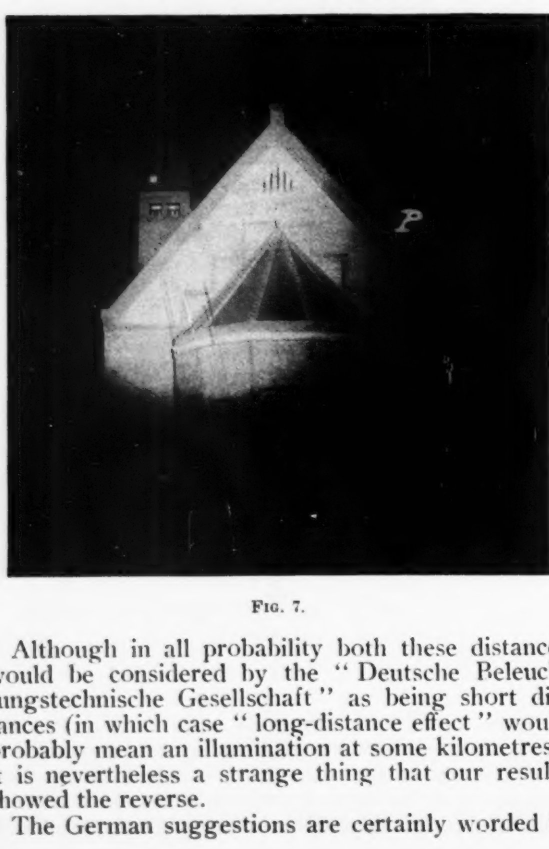


FIG. 7.

Although in all probability both these distances would be considered by the "Deutsche Beleuchtungstechnische Gesellschaft" as being short distances (in which case "long-distance effect" would probably mean an illumination at some kilometres), it is nevertheless a strange thing that our results showed the reverse.

The German suggestions are certainly worded in very vague terms. People who are concerned with projectors for the floodlighting of buildings will probably regard an illumination at a distance of 140 metres as coming under the heading of "long-distance." In view of the fact that buildings are nowadays being floodlighted at short distance (about 10 to 20 metres) by means of enamelled projectors, the present tendency will be to call this a "short-distance" effect, whereas floodlighting at a distance of 100 to 150 metres will most likely be classified as "long-distance work."

The differences in the percentage of luminous intensity at the boundaries of the beam when directed on these objects, must therefore be due to other causes than the difference in distance.

For instance, one of the causes may be the difference in brightness of the white house as compared with the brightness of the illuminated trees; moreover, the fact that the front face of the house was of uniform whiteness and that the group of trees naturally showed considerable difference in reflection might very well cause the observer to notice a difference of brightness on the white house sooner than on the group of trees.

We have come, therefore, to the following conclusion:

> Designers of floodlight installations should certainly know the spread of projectors for various percentages of the maximum luminous intensity. After they have carefully considered the nature of the objects to be floodlighted, they will find it very helpful to know at what spread of the beam a percentage of 10 per cent. and 50 per cent. (perhaps also 25 per cent.) is obtained.
>
> It is incorrect and confusing to associate this demarcation of the beam with a difference in the distance of the illuminated object.

We therefore suggest that manufacturers of projectors should state the following particulars:

(1) The source of light with which the measurements were made.

(2) The maximum candle-power of the beam, eventually calculated for 1,000 lumens of luminous flux coming from the source of light.

(3) The spread corresponding to 50 per cent. of the maximum candle-power.

(4) The spread corresponding to 10 per cent. of the maximum candle-power. (In the case of beams which are practically symmetrical on all sides, the luminous intensities constituting the boundary values can be taken as the average luminous intensities.)

(5) The beam-flux radiated in the solid angle referred to under (3). This beam-flux may be expressed in relation to 1,000 lumens of the luminous-flux from the lamp.

(6) The corresponding beam-flux radiated in the angle referred to under (4).

To these data might eventually be added the spread and the beam-flux corresponding to 25 per cent. of the maximum luminous intensity.

As regards the measurement of the spread, we would point out that the constructor must be free to select any direction he desires as the axis of the beam, and must therefore not be bound down to the optical axis of the projector. In order to arrive at the best possible value, he may select this axis of the beam in such a manner that the spread for 10 per cent. and 50 per cent. and also the beam-flux radiated in these angles are as large as possible.

If the beam-axis direction taken for these measurements varies considerably from the axis of the beam-light, it will be desirable to indicate the angle of deviation.

In the case of beams which are practically symmetrical in all directions, as is generally the case, the best way will be to fix the proposed boundaries of the beam at the angles under which the *mean* luminous intensities amount respectively to 10 per cent., 25 per cent., and 50 per cent. of the maximum luminous intensity. In the examples given below we have followed this system in measuring the spread of the beams. (In the literature on this subject we have not found any better way of defining the boundaries of beams.) In the case of highly asymmetrical beams it will, of course, be necessary to give separate data for various planes of the beam.

The beam-flux will have to be determined by reference to the light-distribution curve, since measurements effected by means of a semi-sphere with a compensating screen or a full sphere with a hole through which the beam passes, would necessitate excessively large integrators, not to speak of the difficulties of standardization in using a sphere.

In the case of Philips "Philiflood" Fl.22 with a searchlight lamp of 220 volts 1,000 watts and having a spread with 10 per cent. boundary, the diameter of the beam at a distance of say 20 metres will be about 6 metres, so that it would be necessary to use a hemisphere with a diameter of at least 6 metres.

It is therefore important to be able to measure and plot the light-distribution of a beam in such a manner that the luminous flux can easily be ascertained from the graph.

This measurement of the light-distribution may be effected in various ways:

1. The projector is made to rotate first on a fixed horizontal axis (perpendicular to the axis of the beam-light) and then on an axis which is vertical when in the initial position and which joins in the rotation about the horizontal axis.

By this method each direction can be indicated by two angular values, which are to be considered as the "length and breadth" of a spherical system of co-ordinates, the two poles being situated on the horizon in the direction perpendicular to the axis of the beam-light; the "equator" of this system passes through the zenith. The "length" is then the angle of rotation on the horizontal axis, whilst the "breadth" is the angle of rotation on the axis which is normally vertical.

Apparatus operating on this principle are illustrated, for instance, in Walsh's "Photometry" (page 421) and in "Eclairage par projecteurs" (page 100, published by the "Soc. franc. pour le perfectionnement de l'éclairage," 1931). Also the measurements in our Illuminating Engineering Laboratory have hitherto been effected with an apparatus working on the same principle.

2. The projector is made to rotate first on a fixed vertical axle and then on a horizontal axle (joining in the first rotation).

When the measuring directions are again indicated in the spherical system of co-ordinates as under (1), the poles will be situated on the zenith and nadir. The "equator" of this system coincides with the horizon. The "length" is here the angle turned through on the vertical axle, whilst the "breadth" is the angle turned through on the normally horizontal axle.

Born gives an illustration showing an apparatus working on this principle.*

3. A third method of measurement consists in making the projector rotate on the axis of the photometer and then about a fixed vertical axle.

In this case the measuring directions can be recorded with the aid of a system of co-ordinates the poles of which are on the axis of the photometer. The "length" here is the angle of rotation on the axle of the photometer, whilst the "breadth" is the angle of rotation on the vertical axle.

This method of measurement is mentioned by Rose.*

If the various directions in which the measurements are effected form comparatively small angles with the direction of the axle, the results obtained by the first and second methods will be approximately the same.

It is therefore not generally indicated in the various publications which of these two methods has been followed in plotting an isocandle diagram. If, however, the angular values are greater than 10 to 15 per cent. different results will be obtained in applying the first and second methods which will be very difficult to show in a diagram. For this reason the method followed by Rose is far more logical. The diagram obtained by him from his measurements must always be drawn through poles, so that there will never be any difference of opinion as to the method of plotting.

This third method has, moreover, the following advantages:

(*a*) The luminous flux can be integrated in a very simple manner. If all the values situated on one circle are averaged arithmetically, it is possible, by using a Rousseau diagram, to integrate these average values and thus to arrive at the total luminous flux. If we wish to measure the luminous flux from the values arrived at by the first two methods, it will first of all be necessary (especially if the measurements have been effected under fairly large angles) to record the figures arrived at in the cylindrical or sinusoidal projection of the surface of the sphere. We shall then have to determine by interpolation the mean luminous intensity of each section, after which the luminous flux can be ascertained by multiplying areas and luminous intensities.

(*b*) Since in most cases the isocandles will not show excessive deviations from the circular form, the isocandles can be drawn far more easily from the luminous intensities plotted in this manner than from the light-distribution curves plotted by the first and second methods.

The method of measurement indicated by Rose has, however, with the advantage of easy integration, the great disadvantage of being quite unserviceable for measuring all beams obtained by means of lamps which have to burn vertically, whether cap downwards (cinema and projector lamps) or cap upwards (cinema and aeroplane lamps), but even in measuring lamps which, without directly impairing their length of life, can be used in different positions, the method involves the drawback that when burning in positions which deviate considerably from the normal, the gas currents in gas-filled lamps are different, which in most cases results in a measurable alteration in the luminous intensity of the lamps.

With the method of rotation on a horizontal and on a vertical axle the burning position of the lamp does not vary to any considerable extent during measurement. Strictly speaking, we ought to keep the projector in the normal position during measurement and let the photometer move in the beam. In practice this is generally impossible.

With apparatus for method 1 or 2 it is, of course, possible to obtain all positions that are required for integration by the co-ordinates system of method 3. It becomes necessary, however, to convert a whole network of co-ordinates into the radial angles which

* *E.T.Z.*, *52*, 1,239, 1930.

* *Gen. El. Rev.*, *20*, 748, 1917.

are necessary for reaching these measuring positions.

Apart from the fact that this calculation is comparatively complicated, the difficulty remains that these angles will never be plain angles, and will therefore always be very awkward to adjust. This method thus entails a much greater risk of error.

The demand therefore arose for an apparatus which, while possessing the advantage of comparatively slight change in burning position when rotating on the horizontal and vertical axle, will nevertheless ensure simple adjustment of the measuring positions required for easy integration.

A solution of this problem has been found by fixing the beam-light in the innermost of two Cardan rings. This principle was elaborated in the Philips Illuminating Engineering Laboratory. We are giving below a description of the construction of this apparatus (see Fig. 8).

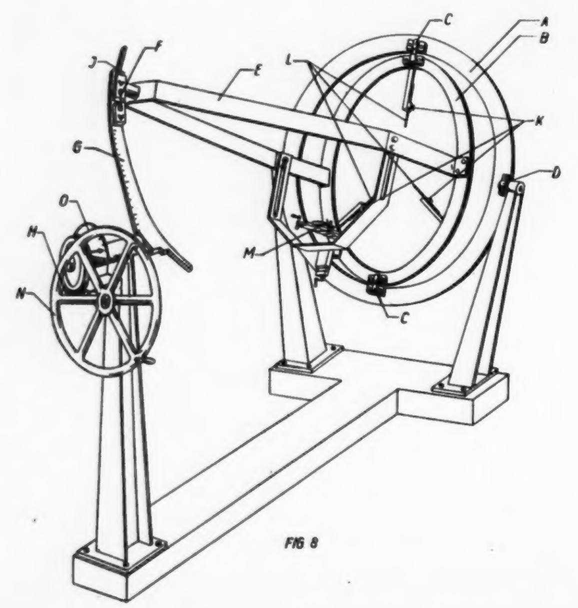


FIG 8

The projector is fixed in the innermost of two rings A and B suspended by a Cardan joint, which rings can rotate on the journals C and D. A fork E is fixed to the innermost ring. By means of the slider F this fork can be moved to different positions and fixed on a strongly constructed protractor G, which can revolve on one of its extremities by means of a worm gear H. The connection between the slider and the fork is formed by a ball which exactly fits into a cylindrical slot in the slider. The protractor G is provided with a vernier J for adjustment to within one-eighth of a degree.

For fixing the beam-lights there are three sockets K distributed at equal intervals round the innermost ring. Three rods L can move radially in these sockets, and a beam-light can be clamped in position between the ends of the rods. These rods are fixed by bolts after clamping, and thus the beam-light can be accurately centred.

Fitted to the fork E there is furthermore an adjusting device M consisting of lathe supports, so that, if necessary, a lamp can be very accurately adjusted in a reflector mounted on these supports. It is also possible to mount in this way a complete projector for the purpose of accurate adjustment, or any optical system (e.g., a projection device) which it is desired to measure.

Motor-car headlights require a special fixing device consisting of a removable socket which can be adjusted in an upward direction and into which a 30-mm. journal will fit. The motor-car headlights must therefore have journals of 30 mm. diameter.

If we adjust the slider F at a certain number of degrees on the protractor, we can, by turning the protractor by means of the worm (which is moved by the handwheel N), effect any number of measurements, all of which will indicate luminous intensities in directions forming the same angle with the axis of the beam-light. The position of the protractor G can be checked on a protractor O after the worm H has been moved.

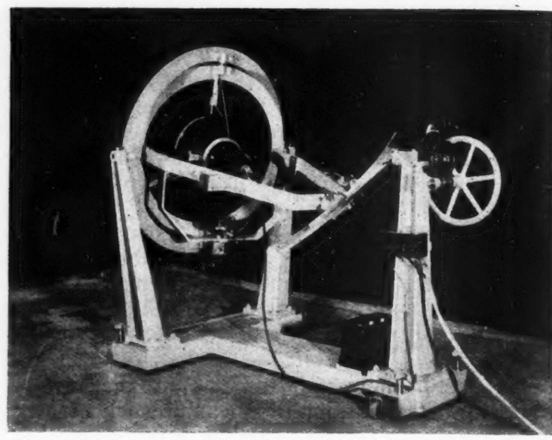


FIG. 9

The measurements effected at the same angle can be integrated, thus giving an "integrated" light-distribution curve for the projector, and from this curve we can ascertain the spread of beams that are practically symmetrical on all sides.

Fig. 9 gives a photo of the apparatus, in which a Philips "Philliflood" beam-light is fixed, whilst

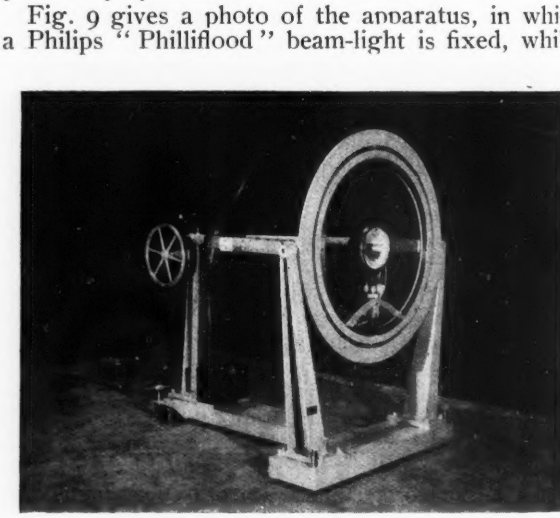


FIG. 10.

Fig. 10 shows the same apparatus with a motor-car headlight mounted in it.

The following two examples will serve to illustrate this method:—

1. Measurement of a Philips "Philiflood" projector Fl., C2. Source of light: 110-volt-1,000-watt searchlight lamp. The luminous intensity is measured by means of the above-mentioned apparatus and a Weber photometer, on circles situated $\frac{1}{4}°$, $\frac{1}{2}°$, $\frac{3}{4}°$, $1°$, $1\frac{1}{2}°$, $2°$, $2\frac{1}{2}°$, $3°$, $3\frac{1}{2}°$, $4°$, $4\frac{1}{2}°$, $5°$, $6°$, $7\frac{1}{2}°$, $10°$, $12\frac{1}{2}°$, $15°$, $17\frac{1}{2}°$, $20°$, outside the axis of the beam. Four measurements are effected on the circles up to and including $1°$, twelve measurements on the circles from $1°$ to $3°$ inclusive, sixteen measurements on the circles from $3°$ to $6°$

inclusive, and twenty-four measurements on the circles from 6° to 25° inclusive. The mean values of these measurements are then ascertained for each circle, which can be effected either by calculation or graphically by plotting the measured values in a rectangular system of co-ordinates and planimetering the area enclosed by the curves thus obtained. Some examples of this latter method are given in Fig. 11.

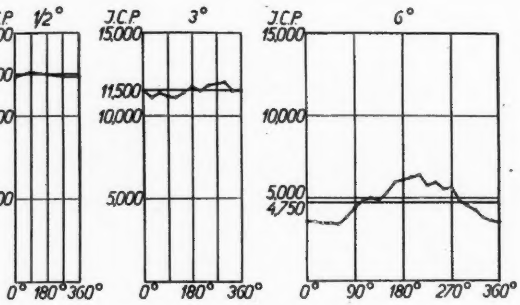


FIG 11

The mean values thus arrived at can be plotted in a rectangular system of co-ordinates with the angles of radiation as abscissæ (Fig. 12). In this way we obtain an "integrated" light-distribution curve from which the spread can be ascertained. The mean values can then be plotted in a Rousseau diagram with a large base, and thus the beam-flux can be integrated graphically.

From this light-distribution curve (Fig. 12) the spread for 10 per cent., 25 per cent. and 50 per cent. is found to be 9°, 7° and $5\frac{1}{4}$° respectively.

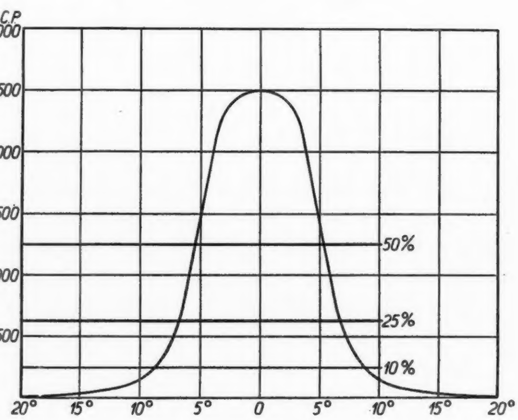


FIG. 12

The beam-flux is integrated in Fig. 13. For the base of the Rousseau diagram we take dimensions of 2 × 10 metres (reduced in the reproduction). If we have to integrate further than about 10° we shall find it advisable to resort to a Rousseau diagram with a ten-times smaller base, as the figure would become inconveniently large if we continued integrating above 10° with a base of 2 × 10 metres. Moreover, in most cases the drop in luminous intensity is so great that a different scale has to be adopted for the luminous intensity.

The distances on the base of Rousseau diagram are arrived at by measurement, in accordance with the formula:

$$a = R(1 - \cos \alpha),$$

where R is half the base of the Rousseau diagram, the angle for which the mean luminous intensity is plotted.

In the above manner we find from Fig. 13 a beam-flux of 418 lumens for the 10 per cent. boundary, 361 lumens for the 25 per cent. boundary, and 267 lumens for the 50 per cent. boundary. These figures and also the candle-powers in Figs. 11 and 12 are indicated with reference to 1,000 lumens of the source of light.

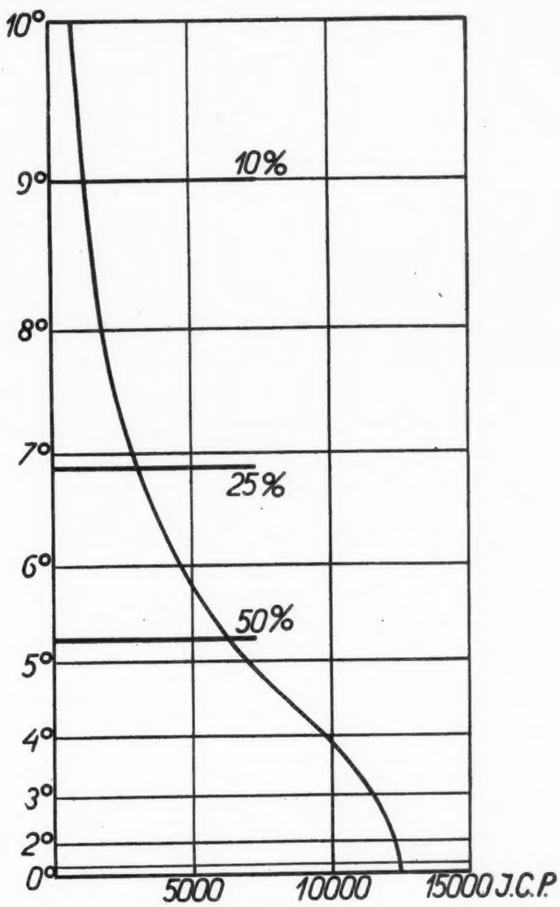


FIG. 13

2. The same procedure was applied for measuring a Philips aeroplane headlight. The reflector of this headlight was a parabola with a focal distance of 24.5 mm. and a diameter of 214 mm. The source of light used was a Philips aeroplane lamp = (24 to 26 volts 40 amps.) of a type specially constructed for aeroplane headlights, which has to burn in a hanging position with the lamp-axis vertical or inclined at an angle up to 20° from the vertical. A beam-light containing this lamp must therefore never be turned on its axis.

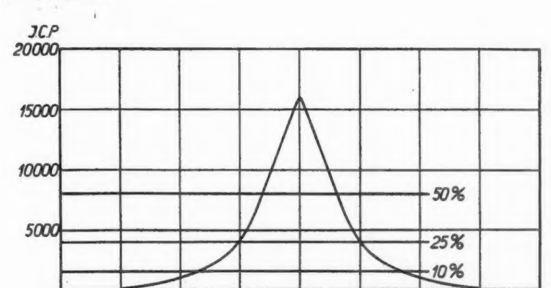


FIG. 14

Fig. 14 gives the mean light-distribution curve for 1,000 lumens of the source of lights, this curve being plotted in a rectangular system of co-ordinates. From this curve we find that the spread for the 10 per cent. boundary amounts to $8\frac{3}{4}$°, for the 25 per cent. boundary 5°, for the 50 per cent. boundary 3°.

Fig. 15 gives the Rousseau's diagram, from which we obtain beam-fluxes of 110, 198 and 339 lumens respectively for the 50 per cent., 25 per cent. and 10 per cent. boundary in relation to 1,000 lumens of the source of light.

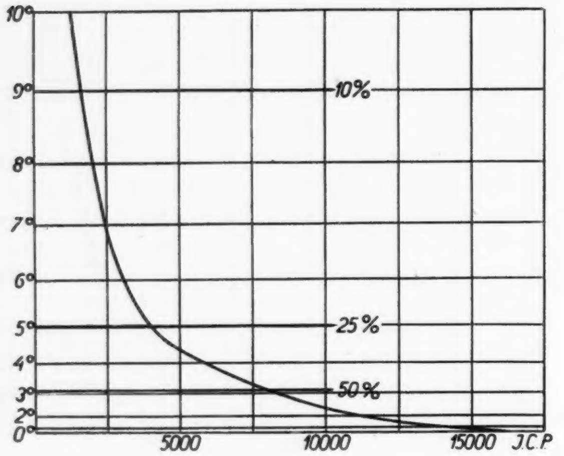


FIG 15

3. Asymmetrical sources of light can also be successfully measured with the type of apparatus described above, and from the values thus found we can again easily determine the beam-flux.

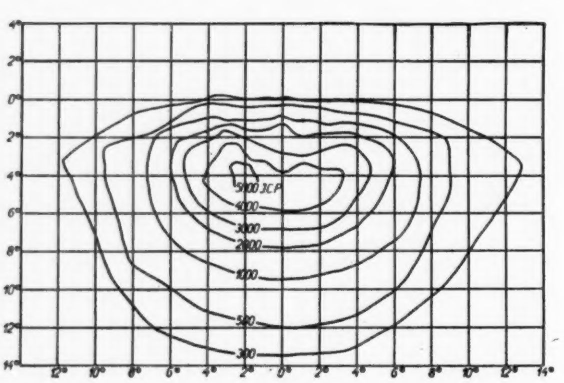


FIG 16

As an example we are giving in the accompanying figures the measurement of a Zeiss motor-car head-light with a focal distance of 44 mm. and a diameter of 200 mm., in which the source of light was a Philips " Duplo " lamp (12 to 14 volts, 50 candle-power), the " duplo "-ed beam of which we measured. Fig. 16 gives the isocandle diagram as calculated from the measurements taken, whilst Fig. 17 gives a mean light-distribution curve of the beam under the horizontal, from which the Rousseau diagram illustrated in Fig. 18 was derived. In these curves the mean value was determined only for the beam under the horizontal plane passing through the headlight, since this was the only important value required for this measurement. We can, of course, measure in a similar manner the beam-flux above the horizontal plane.

Summary.

1. In the course of a few experiments the authors found that the definition given by the " Deutsche Beleuchtungstechnische Gesellschaft " for " beam-spread " is in general not correct, apart from the fact that the distinction made between a spread for long distance and one for short distance is rather vague.

It is, of course, desirable to state at least two spreads: one with a boundary luminous intensity of 50 per cent. and one with a boundary luminous intensity of 10 per cent. of the maximum luminous intensity, and we may also indicate the spread for 25 per cent. by way of completing the data. The respective beam-flux can be stated in each instance.

2. An apparatus for the measurement of beam-lights has been described here, which offers great advantages over other types, especially for the integration of beam-flux.

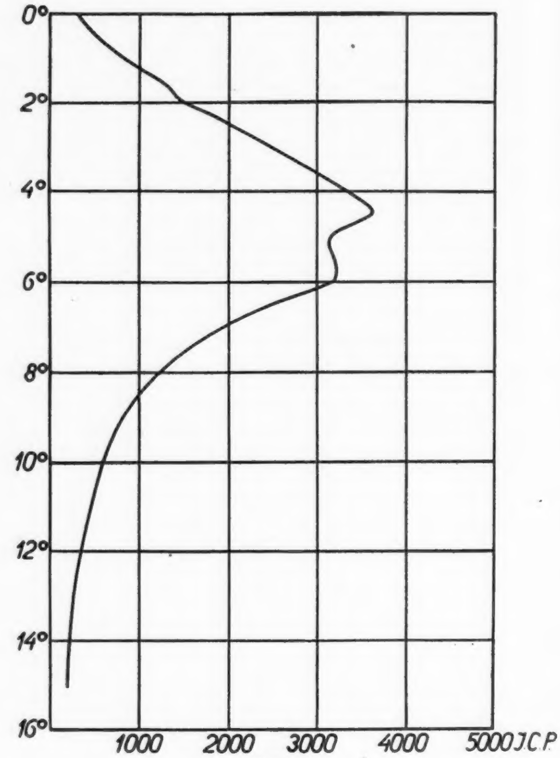


FIG 17

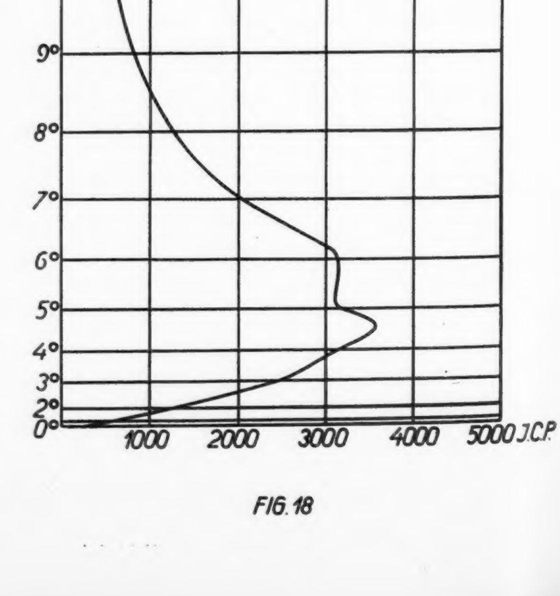


FIG. 18

Literature on Lighting

(Abstracts of recent articles on Illumination and Photometry in the Technical Press)

(*Continued from page* 192, *August*, 1931.)

Abstracts are classified under the following headings: I, Radiation and General Physics; II, Photometry; III, Sources of Light; IV, Lighting Equipment; V, Applications of Light; VI, Miscellaneous. The following, whose initials appear under the items for which they were responsible, have already assisted in the compilation of abstracts: Miss E. S. Barclay Smith, Mr. W. Barnett, Mr. S. S. Beggs, Mr. F. J. C. Brookes, Mr. H. Buckley, Mr. H. M. Cotteril, Mr. J. S. Dow, Dr. S. English, Dr. T. H. Harrison, Mr. C. A. Morton, Mr. G. S. Robinson, Mr. W. C. M. Whittle and Mr. G. H. Wilson. Abstracts cover the month preceding the date of publication. When desired by readers we will gladly endeavour to obtain copies of journals containing any articles abstracted and will supply them at cost.—ED.

I.—RADIATION AND GENERAL PHYSICS.

183. The Photo-electric Emission of Thin Films. N. R. Campbell.

Phil Mag., 12, *pp.* 173-185, *July*, 1931.

A study of the thin films formed by heating oxidised silver and some other metals in caesium vapour. Evidence is presented that excess of Cs may alloy with Ag and produce a mixture of Cs_2O and Ag on the molecular scale. Theoretical discussion shows that results are consistent with Fowler's theory of selective emission. H. B.

184. The Restoration of Solarized Ultra-Violet transmitting Glasses by Heat Treatment. A. Q. Tool and R. Stair.

Bureau of Standards Journal of Research, *Vol.* 7, *No.* 2. *August*, 1931.

In this paper data are given which show the ultra-violet transmissions of two commercial glasses (vita and helio glass) before and after solarization by ultra-violet radiations at ordinary temperatures, and also after various heat treatments in the range 200° to 600° C.

W. B.

185. Symposium on Ultra-Violet Measurements.

Am. Illum. Eng., *Trans.*, 26, *pp.* 703-736, *September*, 1931.

An Erythemal Basis for Dual-purpose Lighting. M. LUCKIESH.

Measurement of Biologically-important Ultra-violet Radiation. A. H. TAYLOR and H. H. HOLLADAY.

The Problem of the Definition and Measurement of the Useful Radiation of Ultra-violet Lamps. C. H. SHARP and W. F. Little.

G. H. W.

186. Industrial Uses of Ultra-Violet. E. E. Free and C. C. Clark.

Am. Illum. Eng. Soc., *Trans.*, 26, *pp.* 744-755. *Sept.*, 1931.

G. H. W.

187. Variation Throughout the Spectrum of the Sensitivity of Cuprous Oxide Cells. Pierre Auger and Charles Lapique.

Comptes Rendus, 193, *pp.* 319-321. 10*th Aug.* 1931.

A photoelectric cell composed of a layer of cuprous oxide (Cu_2O) on a copper plate with a covering transparent film of metal is described. The maximum sensitivity depends on the nature of the metal, but by correcting for the transmission of this film the copper oxide is shown to have a maximum sensitivity of approximately 750 micro-amps. per watt of incident radiation near 4,900 A

S. S. B.

188. The Reflecting Powers of Rough Surfaces at Solar Wavelengths. H. E. Beckett.

Pro. Phys. Soc., 43, *pp.* 227-237. 1931.

Describes an investigation of the reflecting properties of building materials for solar radiation. A hemispherical mirror, used for integrating diffusely reflected energy directed upon a thermopile receiver. Reflecting powers of a large number of building materials for four radiation bands within the solar range, are given. H. B.

189. Experiments on Photoelectric Cells in relation to the Frequency of Illumination. P. Foumarier.

Comptes Rendus, 193, *pp.* 459-461, 21*st Sept.*, 1931.

The experiments were made to study the response of a gasfilled photo cell to a periodic source of illumination. The variable source was obtained by projecting the image of a rectangular aperture in a revolving disc on to a black screen with three white triangles placed in line. The resulting illumination consisted of a constant component of mean value, and an alternating component, very closely sinusoidal, of amplitude equal to the constant value. The two components of the resulting photoelectric current were measured separately. The magnitude of the constant component was found to be independent of the frequency, but the alternating component depended on the voltage applied to the cell, except for very high frequencies. Details and an explanation of the results are given. S. S. B.

190. The Waldner-Burgess Standard of Light. H. T. Wensel, Wm. F. Roeser, L. E. Barbow and F. R. Caldwell.

Bureau of Standards Journal of Research. *Vol.* 6, *June*, 1931.

A source of light sufficiently reproducible to serve as a fundamental photometric reference-standard has been obtained by immersing a hollow inclosure in a bath of molten platinum, as originally suggested by Waidner and Burgess, observations being made during the period of freezing. The platinum, of exceptionally high purity (purer than 99.997 per cent.), was contained in thorium oxide crucibles and was heated by means of a high-frequency induction furnace. The brightness of the source, reproducible to 0.1 per cent., was 58.84 international candles per sq. cm. W. B.

191. Notes on Weber's Law and the Yellow Spot Effect. R. A. Houston.

Phil. Mag., 12, *pp.* 538-551, 1931.

H. B.

192. Some Studies in Pyrometry and on the Radiation Properties of Heated Metals. R. Hase.

Pro. Phys. Soc., 43, *pp.* 212-216. 1931.

A lecture delivered to the Physical Society.

H. B.

II.—PHOTOMETRY.

193. A Daylight Factor Integrator. H. C. H. Townend.

Journal of Scientific Instruments, Vol. VIII, No. 6, p. 177. June, 1931.

This instrument determines mechanically the illumination at a point on a horizontal surface due to the direct light from the sky visible at that point. The instrument is set up at the point, and a telescope incorporated in it is made to traverse the boundary of the visible sky. The illumination (daylight factor) is read off from a small integrating wheel.

W. B.

194. A Photometer Eyepiece Utilizing Maxwellian View. J. S. Preston.

Journal of Scientific Instruments, Vol. VIII, No. 6, p. 189. June, 1931.

Describing the design and use of a small photometer employing Maxwellian view. Its development was primarily due to the need for a brightness photometer with a small field of view suitable for polar measurements on diffusing media. By the use of interchangeable lenses and eye-rings, however its usefulness was extended to other purposes. The theory of the photometer is discussed, and a relation giving the appropriate brightness ranges under different conditions is deduced. The photometer-head, which is very compact, and can be used on several types of photometer benches, is identical with that used by the author in the determination of the reflection factor of magnesium oxide. W. B.

195. A Portable Self-levelling Test Surface for Use with an Illumination Photometer. F. J. C. Brookes.

Journal of Scientific Instruments, Vol. VIII, No. 6, p. 205. June, 1931.

The self-levelling device was designed to facilitate the measurement of street illumination in a horizontal plane. The principle and constructional details of the device are shown in a diagram. The plate can be set to within half a degree of the horizontal for angles of tripod tilt up to 25°. W. B.

196. Microphotometric Measurements by Means of a Projector. E. Gwynne Jones.

Journal of Scientific Instruments, Vol. VIII, No. 5, p. 145. May, 1931.

A new method of microphotometry involving the use of an N.P.L. projector and photoelectric cells is described. A bridge method of the cells is adapted to secure more effective working of the electrometer. As an example of the possible applications of this method, darkenings, such as spectral lines, produced on a photographic plate, have been investigated. The absorption of a deci-normal solution of silver nitrate in the ultra-violet region was measured and found to agree satisfactorily with results obtained previously by other workers. W. B.

197. Des Méthodes de Photométrie Photo-électrique. E. Gambetta.

Rev. d'Opt., 10, pp. 297, 324. 1931.

A critical survey of a considerable number of methods which have been used for photoelectric photometry. H. B.

198. A Bibliography on Illumination.

Am. Illum. Eng. Soc., Trans., 26, 611-663, July, 1931.

Sixth bibliography on illumination covering publications from July 1st, 1929, to June 30th, 1930.

III.—SOURCES OF LIGHT.

199. Sunlight Lamps. M. Luckiesh.

Light, 2, p. 32. September, 1931.

A table is given showing exposures in minutes necessary to produce a minimum perceptible erythema upon untanned skin at various distances and inclinations from a sun lamp and reflector.

C. A. M.

IV.—LIGHTING EQUIPMENT.

200. Modern Stagecraft. D. H. N. Caley.

El. Times, 80, p. 493. October 2nd, 1931.

This article describes the new stage-lighting installation at the Coliseum. There is a movable cyclorama lit from above by a bank of coloured horizon floods, and by combining these light of any colour can be obtained on the cyclorama. There are also three 3-kw. cloud projectors and 500-watt ground floodlights. The floats project only two inches above stage level, and give a beam which will fully illuminate a person one foot away. There are six battens and twelve acting area floods. In the dome are two arcs and eight incandescent projectors, each with a colour magazine controlled from the lighting bridge by tracker wires. The switchboard is a four-tier remote-control board and dimmer bank. The whole installation was planned and erected in twelve weeks. G. S. R.

201. Improving Power Factor of Neon Sign lighting. F. E. Ewart.

El. World, 98, pp. 251-252. August 8th, 1931.

Gives methods of deriving from given curves the k.v.a. rating of capacitators for correcting, to a desired value, the power factor of a neon sign and lamp load combination. Examples are worked out.

W. C. M. W.

202. A New Process for the Prevention of Cracking in Lenses for Illumination Purposes. J. Flugge.

Licht-u-Lampe, 20 Heft 18, p. 273. 1931.

An account of the research done in regard to the heat treatment given to the glass and a description of the phenomena of the lens cracking through sudden temperature changes is given. Investigations lead to the conclusion that merely grinding the edges and leaving them unpolished makes the lens liable to crack when subjected to heat changes.

E. S. B.-S.

203. Intermediate Boundary Marker. W. E. Clemson and H. G. Schiller.

Light, 2, pp. 26-7. September, 1931.

The specification for a boundary light issued by the U.S. Department of Commerce, Airway Division, is given together with details of a fitting designed to comply with this specification.

C. A. M.

V.—APPLICATIONS OF LIGHT.

204. Lighting for Community Pageants. T. Fuchs.

El. World, 98, pp. 246-250. 8th Aug., 1931.

Describes, with the aid of diagrams and photographs, the lighting of the Pageant of New Brunswick. The floodlighting was effected by means of 1,000-watt and 1,500-watt louvred floodlights, whilst the stage was illuminated by means of 2,000-watt spotlights. The total lighting load was 211 kw., of which 172 kw. was used on the pageant field and stage. Difficulties were experienced owing to lamp filaments sagging and causing deflection of the beams. W. C. M. W.

205. Interim Report—Committee on Light in Architecture and Decoration.

Am. Illum. Eng. Soc., Trans., 26, *pp.* 700-702. *September*, 1931.

After a discourse entitled "Ten Years Hence," eight illustrated descriptions of lighting installations are given. G. H. W.

206. Economic Artificial Lighting in Hothouses. K. Vogle.

Licht-u-Lampe, 20, *Heft* 6, *p.* 103; *Heft* 16, *p.* 243; *Heft* 17, *p.* 256. 1931.

The economic side of artificial lighting is discussed in a series of three articles. In the first is described the chemical action of light in allowing plants to obtain the constituents of air and water necessary to their growth. The red end of the spectrum supplies the energy for photo-synthesis, the blue promotes growth. The second article deals with the conditions necessary to determine the economic gain in supplementing daylight by artificial light, such as the time taken for a plant to change from one given stage to another. Finally, curves and figures of crop yields and current costs are given for different kinds of plants.

E. S. B.-S.

207. The New Sadlers Wells Theatre. Anon.

El. Times, 80, *p.* 530. 9*th October*, 1931.

Gives illustrations of the proscenium and switchboard. Twenty-three thousand yards of V I R were used in the lighting installation, which is arranged for one-man control. G. S. R.

208. Genuine Golf for Night Play. Anon.

Light, 2, *pp.* 10-11. *September*, 1931.

An account and photographs are given of an illuminated golf course in Chicago. The illumination is obtained from projectors consuming 124 kw. mounted on towers, some of which are 70 ft. high. An average illumination of 10 foot-candles is obtained on the green. C. A. M.

209. Three Years' Progress in Illumination. J. W. T. Walsh.

World Power, 16, *pp.* 188-194. *September*, 1931.

This article forms a review of the progress made in illuminating engineering during the last three years. All branches of the subject are dealt with in detail, and mention is made of the various British Standard Specifications dealing with illumination problems that have been either produced or revised during this period. The view is expressed that the lay mind has now begun to appreciate the importance of good lighting. C. A. M.

210. Electricity at the Zoo. Anon.

Elect., 107, *pp.* 301-6, *and p.* 323. 4th *Sept.* 1931.

A brief description with photographs is given of the floodlight schemes at the Zoological Gardens, London. C. A. M.

211. Electricity and Stagecraft. Anon.

Elect., 107, *pp.* 307-8. 4*th September*, 1931.

Gives detailed account of the stage-lighting at "Waltzes from Vienna," at the Alhambra, London. Comments are made on the excellent results obtained, and various innovations introduced are described. C. A. M.

212. Aerodrome Equipment. Anon.

Elect., 107, *p.* 346. *September* 11*th*, 1931.

Details are given of various types of lighting equipment demonstrated at Croydon Aerodrome on the occasion of the visit of the I.C.I. C. A. M.

213. A New Safety Device at Sea. Anon.

Light, 2, *p.* 37. *September*, 1931.

A photograph is given of the floodlighting of the funnels of the Canadian Pacific Railway liner "Empress of Britain." These have been found to be visible 30 miles away.

C. A. M.

214. Portable Demonstration Apparatus for Sign Lighting Advertisement. O. Hopcke.

Licht-u-Lampe, 20, *Heft* 18, *p.* 271 *and Heft* 19, *p.* 284, 1931.

A detailed description is given of portable illuminated letters, etc., to demonstrate correct and incorrect erection of signs. Three types are discussed: (1) letters formed by filament lamps, (2) illuminated painted signs, (3) signs of transparent material illuminated from behind.

E. S. B.-S.

215. The Motor Car is a Creation of Light. T. G. Ward.

El. World, 98, *pp.* 506-508. 19*th Sept.*, 1931.

Describes in detail, with the aid of photographs, the lighting arrangements of the Packard Motor Works at Detroit. Both tungsten-filament lamps and mercury-vapour lamps are used, the loads being 5,958 kw. of the former and 1,459 kw. of the latter.

W. C. M. W.

216. Illuminated Fountain at Brighton. Anon.

El. Times, 80, *p.* 561. 9*th October*, 1931.

A spectacular fountain has been installed in the Victoria Gardens at Brighton, in conjunction with the already-floodlit gardens. This is cylindrical in form, and projects several feet above water-level. There are 30 floodlight projectors mounted in the base of the fountain and fitted with different colour media. These are arranged to switch on and off in turn by a motor-driven flasher giving a continuously varying colour effect. G. S. R.

VI.—MISCELLANEOUS.

217. Brightness Contrasts Determine Visual Efficiency. M. Luckiesh.

El. World, 98, *p.* 280. 15*th August*, 1931.

Brightness contrast is defined as the ratio of the difference in brightness between object and background brightness. A table is given showing brightness contrasts for various substances: metals, woods, paints, etc., based on the reflection factors of the materials. W. C. M. W.

218. Better Lighting for Older Eyes. M. Luckiesh.

El. World, 98, *pp.* 516-517. 19*th. Sept.*, 1931.

The power of accommodation of the eye decreases with advancing age. Visibility, however, may be definitely improved by increasing the intensity of illumination. It is shown by means of a table that higher levels of illumination reduce the handicap of presbyopia.

W. C. M. W.

219. Visual Efficiency in Quiet and Noisy Workplaces. M. Luckiesh.

El. World, 98, *pp.* 472-473. 12*th Sept.* 1931.

Tests have been made in order to determine the deleterious effect of distracting noise on the speed performance of visual work. The distracting noise, in this case that of electric motor-generators, increased the average time required for the test by approximately 6 per cent.

W. C. M. W.

Some Further Floodlighting Installations

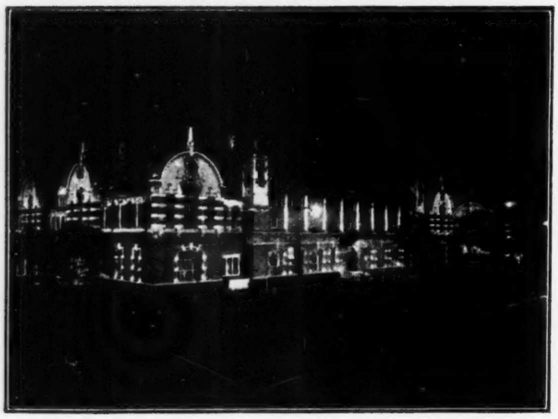


FIG. 1.—The West Ham Technical Institute and Library.

FIG. 2.—The L.C.C. School of Engineering and Navigation, Poplar.

IN what follows we give a brief account of some additional floodlighting installations undertaken in connection with the International Illumination Congress. Those described in our last number* were situated mainly in the vicinity of the Embankment, St. James's Park and Trafalgar Square, but there were many other installations, some of considerable interest, scattered about London.

In Figs. 1 and 2 we illustrate two simple but effective installations. The West Ham Technical Institute and Library was illuminated by means of 28 Holophane projectors equipped with 500-watt gasfilled lamps, the L.C.C. School of Engineering and Navigation, Poplar, with six projectors of similar type and wattage.

Our third picture, showing the floodlighting of the tower and dome of the Council House, Nottingham, is a somewhat remarkable one. We are indebted for this illustration to the Edison Swan Electric Co. Ltd. We understand that in all 112 1,000-watt projectors were used. The illumination afforded, stated to be of the order of 40-50 foot-candles, was probably the highest used in any of the I.I.C. installations and it is not surprising to hear that the tower and dome stood out very effectively indeed.

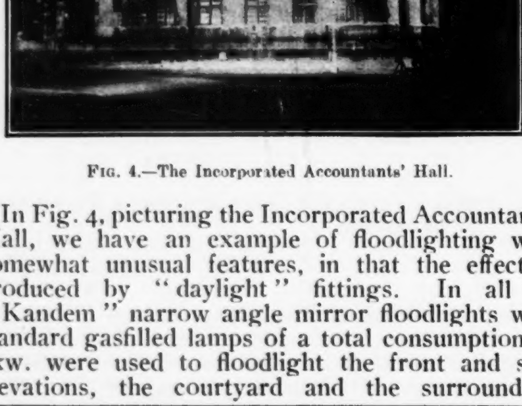


FIG. 4.—The Incorporated Accountants' Hall.

In Fig. 4, picturing the Incorporated Accountants' Hall, we have an example of floodlighting with somewhat unusual features, in that the effect is produced by "daylight" fittings. In all 13 "Kandem" narrow angle mirror floodlights with standard gasfilled lamps of a total consumption of 9kw. were used to floodlight the front and side elevations, the courtyard and the surrounding lawns. The installation was carried out in conjunction with Messrs Restlight Ltd., each floodlight being fitted with a special front glass, so as to give light approximating closely to daylight in colour. The contrast and play of light and shadow was such that the architectural features of the buildings were quite as noticeable as in daylight, and people were impressed by the natural appearance of the lawns and certain portions of the walls which differed in colour. This installation, we are informed, was the only one of its kind carried out during the Congress and furnished a good example of what can be done to create interest with very moderate brightness of effect. We are indebted to Messrs Korting & Mathiesen Electrical Ltd. for the illustration accompanying this note.

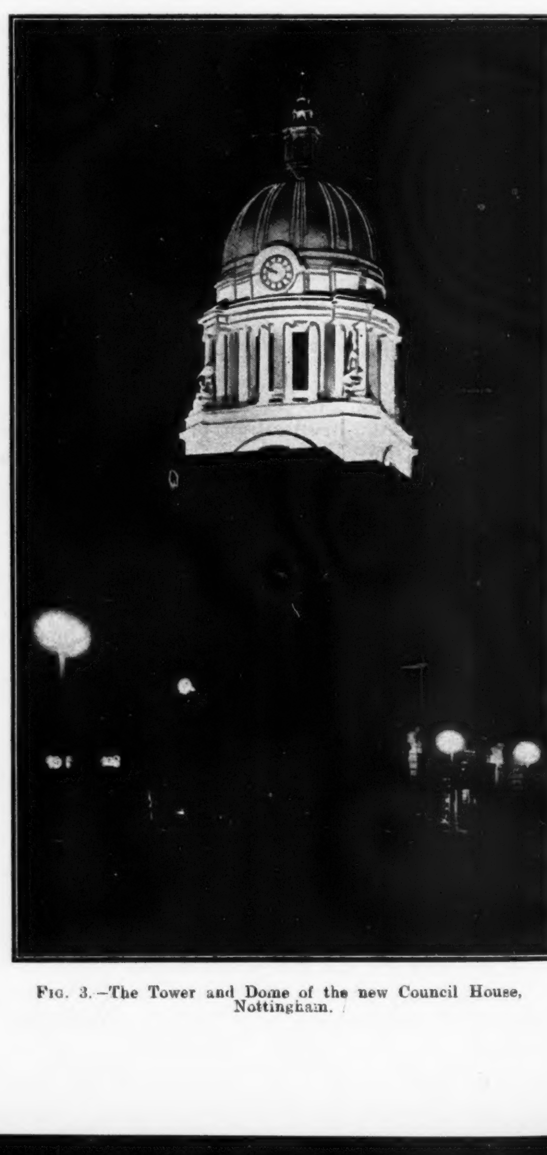


FIG. 3.—The Tower and Dome of the new Council House, Nottingham.

* *The Illuminating Engineer*, October, 1931, pp. 243-260.

Fig. 5.—Marylebone Town Hall.

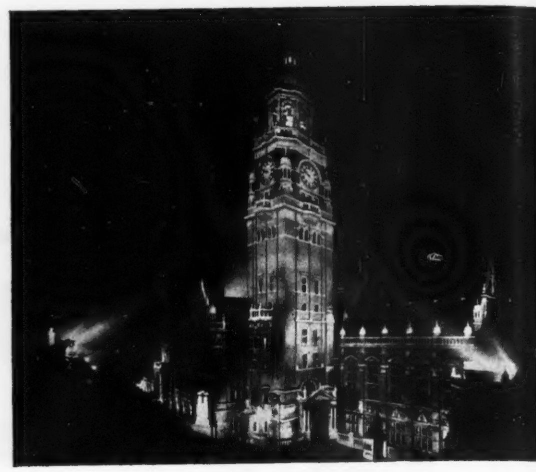


Fig. 6.—Croydon Town Hall.

Two other town halls, those at Marylebone and Croydon, are illustrated, in our next two pictures (Figs. 5 and 6), for which we are indebted to the General Electric Co. Ltd. The Marylebone Town Hall received illumination from 38 1,000-watt projectors, only white light being utilized. For the lighting of the Croydon Town Hall 70 1,000-watt projectors of various types were used. In this case a striking colour scheme was aimed at, the lower portion of the building being floodlighted in red and the main tower in white, whilst the belfry was floodlighted in red from within.

Our final illustration, for which we are indebted to the courtesy of the *Gas Journal*, shows the "relief" lighting of the Town Hall, Birmingham. The lighting is effected by two concealed high-pressure gas lights, of 1,500 candle-power, equipped with parabolic reflectors and placed at the foot of and just behind each of the Corinthian columns which surround the main body of the hall. There are fifteen columns on each side of the building and eight columns in front. This is stated to be the only serious attempt to floodlight a public building in this way by gas during the period of the International Illumination Congress. In spite of the blackened condition of the building, which naturally was far from favourable to floodlighting, the effect is quite impressive. The method is distinctive in that the concealed sources illuminate the wall in such a way as to form a relatively bright background against which the pillars appear "silhouetted." For this reason the effect has been described as "relief lighting." The contrast is of course reversed as compared with daylight. It is an interesting question how far architects will approve such reversals, which are a familiar feature of floodlighting with artificial light. Most people, however, would probably consider that the appearance by night of a series of pillars illuminated in this way is quite as impressive as the appearance by daylight, and that the architectural features, though presented in a new aspect, are equally recognizable.

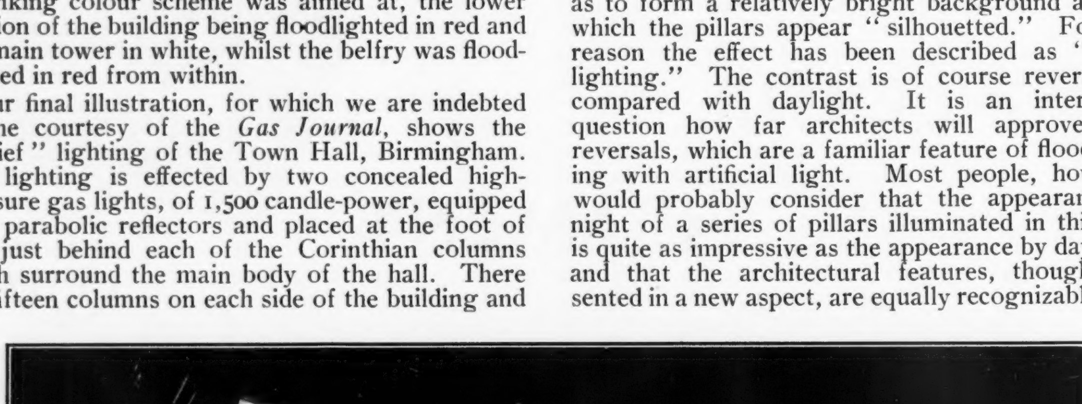


Fig. 7.—"Relief" Lighting with Gas of Birmingham Town Hall.

FIG. 1.—Eastbury House. Trees and front illuminated by fifteen gas projectors.

Celebrations at Barking

Floodlighting by Gas

ON the 5th October Barking Town received its charter of incorporation from the hands of H.R.H. Prince George. The town now becomes a municipal borough, instead of an urban district.

A week of celebrations followed the presentation of the charter, the principal events being an exhibition of the products of the town, and a pageant showing episodes in the history of Barking through twenty centuries.

A feature of these celebrations which is of interest to illuminating engineers was the floodlighting of buildings of historic and local interest by means of gas projectors. Among the buildings illuminated were the Public Library in Ripple Road, the lodge at the entrance to the park, and Eastbury House.

The Public Library.

This building was illuminated by fourteen parabolic gas projectors arranged in two batteries—one on each extreme corner, so that the slight relief on the face of the building was accentuated. In addition, one lamp was placed behind each of the gate pillars to increase the illumination on the centre of the building.

Eastbury House.

This fine Elizabethan mansion is said to be the house in which the Gunpowder Plot was hatched.

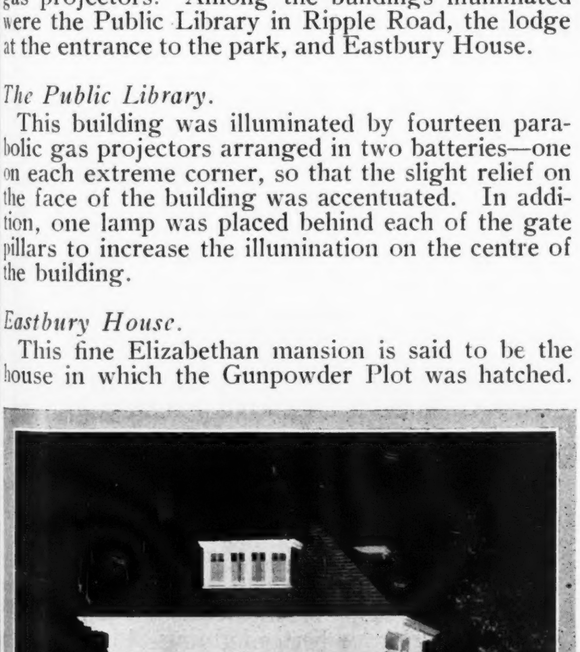


FIG. 2.—The Park Lodge. Building and surrounding trees and shrubs illuminated by five gas lamps.

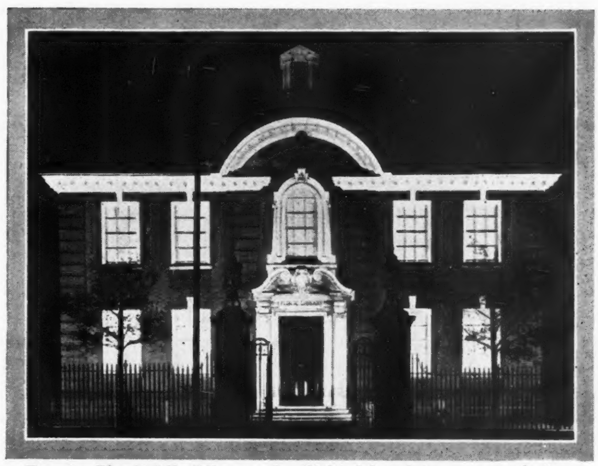


FIG. 3.—The Public Library—floodlighted by sixteen gas projectors.

It was at that time the residence of Lord Monteagle, one of the conspirators.

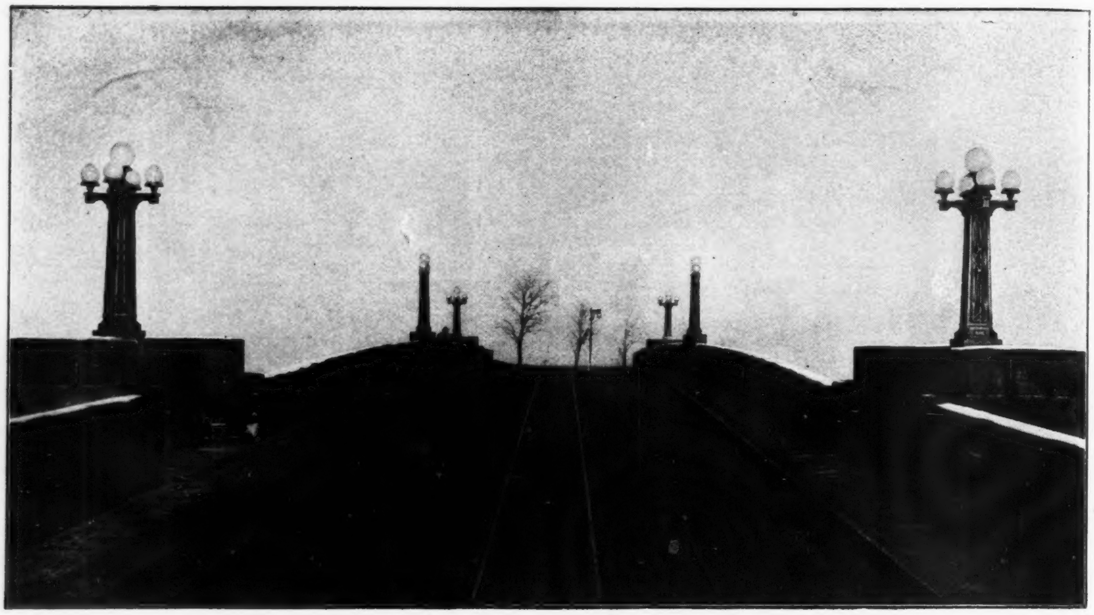
In planning the floodlighting, the aim was to show up the difference in texture between the trees in front and the building behind. Fifteen gas lamps were used, and those lighting the trees were placed almost immediately under the branches in order to provide maximum contrast. A too even illumination of the house was debliberately avoided, in order to accentuate its appearance of antiquity.

Park and Lodge.

This charming little building was illuminated by three parabolic lamps placed in the garden near the fence. Two other lamps lit up the large tree at the side of the lodge and the geranium bed.

Strip lantern projectors were also placed round the shrubbery on the right-hand side of the Park entrance. The projectors were identical in design with those used recently for the illumination of portions of St. James's Park. Full particulars of these have already appeared in *The Illuminating Engineer.*

There is no doubt that the successful use of gas for flood and landscape lighting during the recent International Illumination Congress has brought home to public authorities and others the possibility of making their show-places interesting and attractive by night. Further developments will be watched with interest by all illuminating engineers.



THE LIGHTING OF GROSVENOR BRIDGE, CHESTER

We give above a view of the Grosvenor Bridge, Chester, which has been furnished to us by Revo Electric Ltd. It will be recalled that this installation was mentioned in our last issue as a good example of bridge lighting, the distribution of illumination over the bridge being very even, whilst the standards on the parapets of the bridge terminate in diffusing globes which prevent any tendency to glare.

Faraday's Work and its Results in Lighting Development

THE first lecture of the Faraday Illumination Design Course (the twenty-fourth to be held by the Lighting Service Bureau) was given on Monday evening, October 12th. We understand that the total number of acceptances received to invitations sent out attained 217 this year, an increase of 50 per cent. on last year's figures. The acceptances were distributed as follows: Contractors, 91; supply undertakings, 45; wholesalers, 19; manufacturers, 49; miscellaneous 13.

Mr. W. J. Jones, M.Sc., Manager of the Bureau, who delivered the opening lecture, took as his subject "Faraday's Work and its Results in Lighting Development." He remarked that "there are some men who do brilliant work, but can neither mix with their fellows nor have the ability to extend their results. Not the least important part of Faraday's work was that of his extraordinary power as a teacher and as a lecturer. He filled the Royal Institution to overflowing with brilliant audiences, and one of the great charms of his lectures was the fact that they were fully illustrated by means of fascinating experiments. 'Seeing is believing' was almost a creed with Faraday, and one which we in the lighting industry believe to be of cardinal importance. . . . . Visionary and seer as he undoubtedly was, he could not possibly have foreseen the development of the 60,000 kilowatt generator from his 'toy' electro-magnetic machine, nor the application of electro-magnetic induction in the static transformer, which plays such a big part in the distribution of electricity at the present time. The grid would have been an impossibility without Faraday's pioneer work."

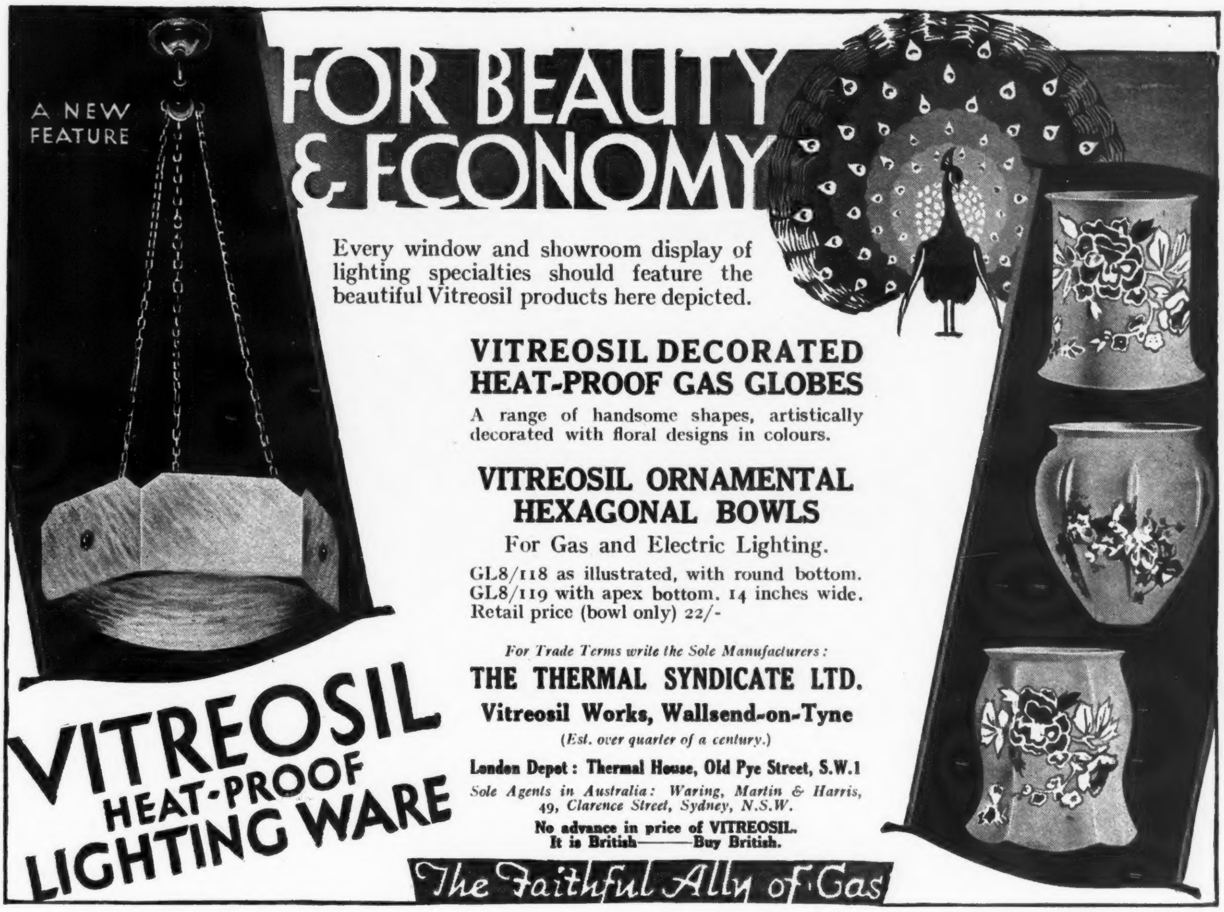
The lecturer emphasized that electric light, which was the main reason originally for inaugurating electricity supply, still occupies the most important place in the electricity industry as a source of revenue and as an agency for electrical development.

Mr. Jones illustrated the value of Faraday's work by an interesting calculation: "If we assume as a basis the cost of providing 100 candle-power for 1,000 hours," he said, "we find that if we used candles the cost would be £55. At the present day, with a modern lamp and a reasonable price of electricity, the cost of a 100-candle-power lamp for 1,000 hours is 36s. 1d. You will remember that primary batteries represented the sole means of obtaining electricity prior to Faraday's work; if we used the most efficient primary batteries and the most efficient electric lamps, the cost of providing 100 candle-power for 1,000 hours would be £10. In other words, *each one of us using electric light owes a debt of gratitude to Faraday to the extent of 16s. 6d. in the £.*" Later, the lecturer made another point by remarking that good lighting in the home costs less than a packet of 10 cigarettes a day.

The lecturer deprecated undue insistence on technical efficiency. Because of its scientific nature, applications of electric lighting have become hedged round with so-called scientific formulæ. There is need for a fresh outlook. We must rid ourselves of the "engineering efficiency complex" and give more thought to effectiveness. We definitely put a brake on development by arguing on fractions of a foot-candle when the customer is mainly concerned with a satisfactory result. It is sometimes said, even by well-known engineers in the electrical profession that "too much light is bad for the eyes." Mr. Jones contended that, provided that glare is absent, one could use with profit to the comfort of the eye an almost unlimited intensity of light.

An improvement in lighting can hardly take place in one sphere without having its effects in other spheres. For instance, better lighting in trams, buses, shops, theatres and cinemas has undoubtedly created an urge for better lighting at home.

While on humanitarian grounds the intensity of light for the preservation of the eyesight of the worker is important, we have learned during recent years that the economic aspects of good lighting are no less important. Good lighting is a tool which will assist production, and we must emphasize this aspect. The shopkeeper uses light because of its ability to increase sales. In other words, the visibility aspect is secondary to that of creating a business atmosphere.

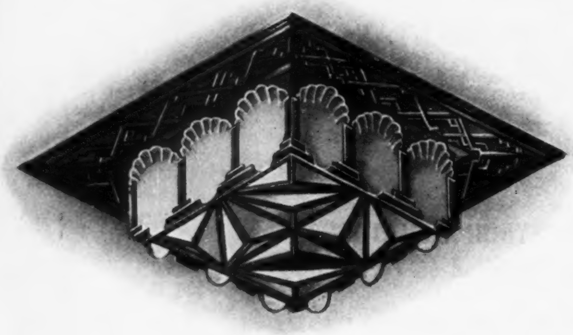


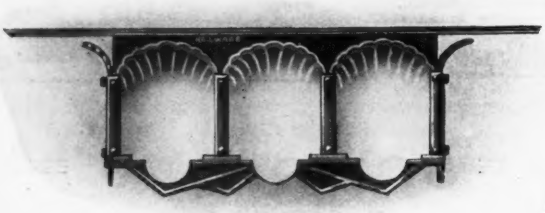
INDEX (November, 1931).

TRADE NOTES & ANNOUNCEMENTS

A Prize Design

We reproduce below perspective and side views of the prize-winning "Design for a Ceiling Electric Light Fitting suitable for a Cinema Entrance" prepared in connection with the Competition of





Industrial Designs (1931) organized by the Royal Society of Arts. Miss Vera Moller of London, the winner of the competition, was awarded the prize of £10 10s. offered by Messrs. Hailwood and Ackroyd Ltd., by whom the sole rights of the design have been acquired.

Tungsram Publicity

We have received from Messrs. Tungsram Electric Lamp Works (Great Britain) Ltd., specimens of Tungsram Publicity designed for the new season. These are set out in an attractive broadsheet which will shortly reach the trade. Details of the national advertising campaign which commences shortly are given. The advantages which Tungsram claim for their lamps are pictorially represented on a centrepiece, printed in six colours, which will form the basis of a forceful window display. In addition there is a smaller showcard, a brightly coloured window streamer, and leaflets giving full details of Tungsram products. Altogether some very attractive sales aids, which should prove useful in stimulating Tungsram sales.

Siemens Floodlighting Units

Leaflets have recently been issued giving particulars of Siemens floodlights which are of substantial construction and utilise chromium plated reflecting surfaces. These floodlights are of two types, extensive (types E.L. and E.S.) and concentrating (types C.P.L. and C.P.S.). The former utilise Siemens standard gasfilled lamps, the latter Siemens projector lamps. The smaller sizes (E.S. and C.P.S.) are adapted for 200-300 and 100-250 watt lamps whilst the E.L. and C.P.L. projectors are intended for lamps of 500 or 1,000-watt capacity.

Another booklet before us contains particulars of varied types of Siemens lamps, both standard and special varieties, and bears on the front page a coloured display featuring "the popular pair" (pearl and opal lamps).

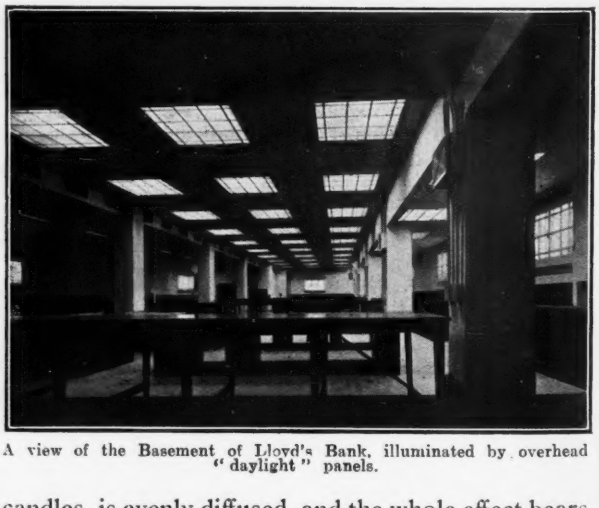
We take the opportunity of recording a further contract placed by the Admiralty with Messrs. Siemens Electric Lamps and Supplies Ltd. for a quantity of gasfilled lamps.

Lloyds Bank

An Interesting "Daylight" Installation

The accompanying illustration, for which we are indebted to Messrs. Restlight Ltd., shows the lighting of the basement of Lloyds Bank, in the City of London, which is illuminated entirely by overhead "daylight" panels, flush with the ceiling. There are in all forty-nine panels, each utilising a 300-watt lamp, and each double-glazed with Restlight glass and Chance's "Dewdrop" glass. The lamps are equipped with silvered metal reflectors and the filaments are partially obscured with aluminium paint, so that each bulb directs light upwards to be again reflected down from the metal reflector. (This arrangement makes for uniform brightness and avoids unsightly "bloom" spots.) The actual height of suspension is 11 ft. 4 in. above the working plane or 14 ft. above the floor.

This method of lighting was adopted owing to the comparative lack of overhead space available and has proved eminently satisfactory. As the picture shows there is a clear view down the room. The illumination provided, almost exactly 15 foot-candles, is evenly diffused, and the whole effect bears a striking resemblance to daylight—a resemblance which is doubtless enhanced by the generous illumination, comparable with that available under good daylight conditions. The specific consumption is stated to be 3.2 watts per sq. ft.



A view of the Basement of Lloyd's Bank, illuminated by overhead "daylight" panels.